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**United States Patent** [19][11] **Patent Number:** **6,149,438****Richard et al.**[45] **Date of Patent:** **\*Nov. 21, 2000**

[54] **SYSTEM AND METHOD FOR THE DELIVERY, AUTHORIZING, AND MANAGEMENT OF COURSEWARE OVER A COMPUTER NETWORK**

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[75] **Inventors:** **Jerry P. Richard**, Lucas; **Richard O'Bryant**, Richardson; **Verlon P. Harmon**, Dallas, all of Tex.

*Primary Examiner*—Jessica J. Harrison  
*Attorney, Agent, or Firm*—W. Daniel Swayze, Jr.; W. James Brady, III; Frederick J. Telecky, Jr.

[73] **Assignee:** **Texas Instruments Incorporated**, Dallas, Tex.

**[57] ABSTRACT**

[\*] **Notice:** This patent is subject to a terminal disclaimer.

A network system for computer aided instruction, comprises a main computer with a repository for storing courseware, a network of servers connected to the main computer, a number of local area networks, each connected to a server, and each comprising a number of interconnected workstations, a distributed delivery system responsive to a student's request for a course, operable to search the network for a server where the requested course resides, and operable to retrieve the course from the repository, and an authoring system distributed over the workstation, the servers and the main computer, and operable to transfer courses from a workstation to the repository, and a course management system distributed over the workstation, the servers and the main computer, and operable to manage course enrollment and to monitor student performance at said servers, and further operable to transfer information concerning course enrollment from said servers to said main computer.

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[22] **Filed:** **Jun. 7, 1995**

**Related U.S. Application Data**

[63] Continuation of application No. 07/742,974, Aug. 9, 1991.

[51] **Int. Cl.<sup>7</sup>** ..... **G09B 5/14**

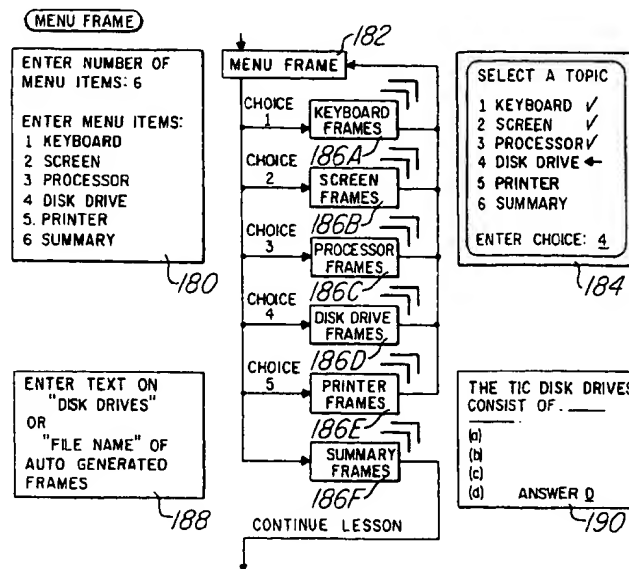
[52] **U.S. Cl.** ..... **434/322; 434/323; 434/335; 434/336; 434/362**

[58] **Field of Search** ..... **434/118, 322, 434/323, 335, 336, 350, 362**

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A computer program having provisions for training users in its use, comprises application code, hook points connected to the application code, and embedded training routines connected to the hook points, so that there is a mapping between the hook points and the embedded training routines. The application code has code responsive to a user action to transfer control from the hook points to the embedded training routines.

**11 Claims, 14 Drawing Sheets**

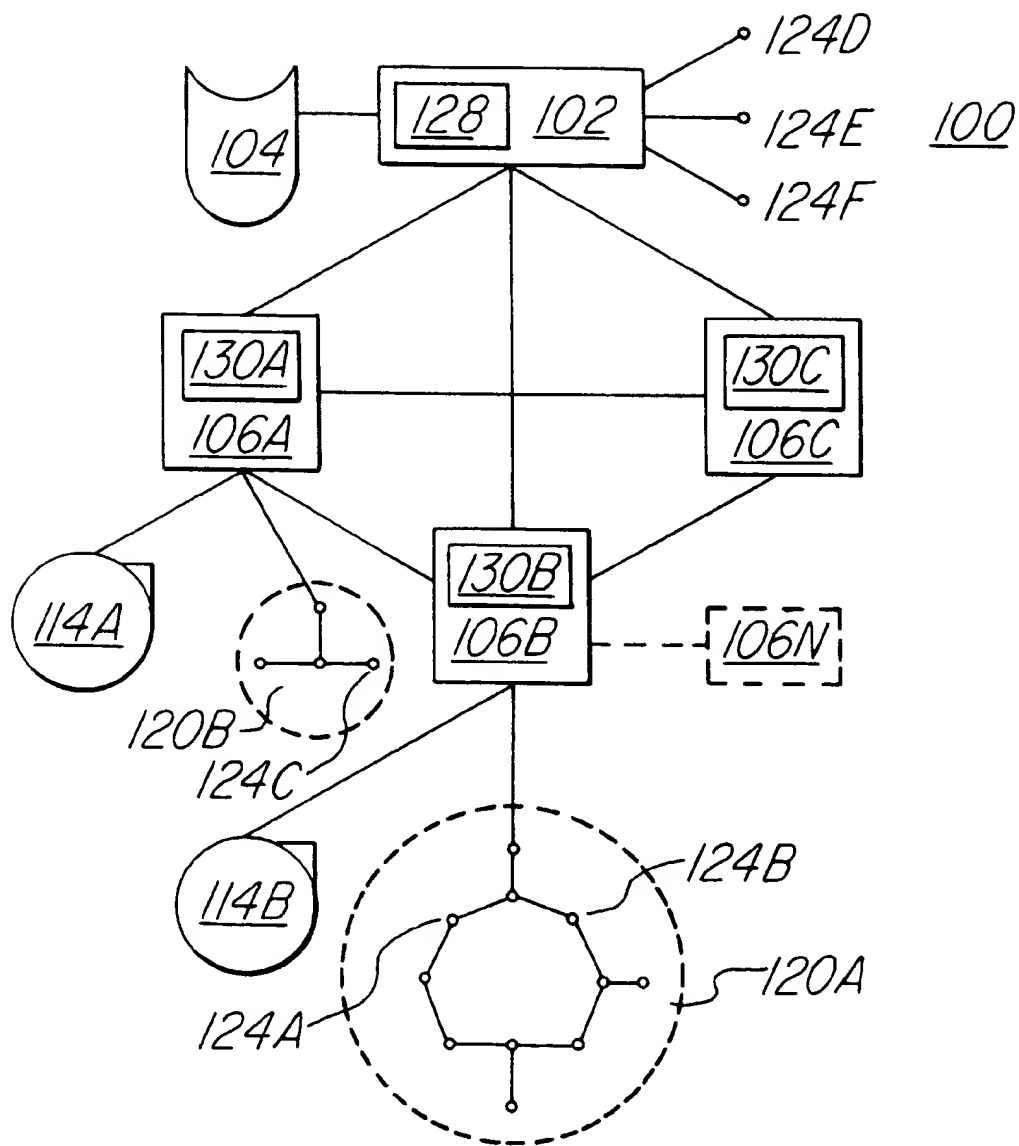


FIG. 1

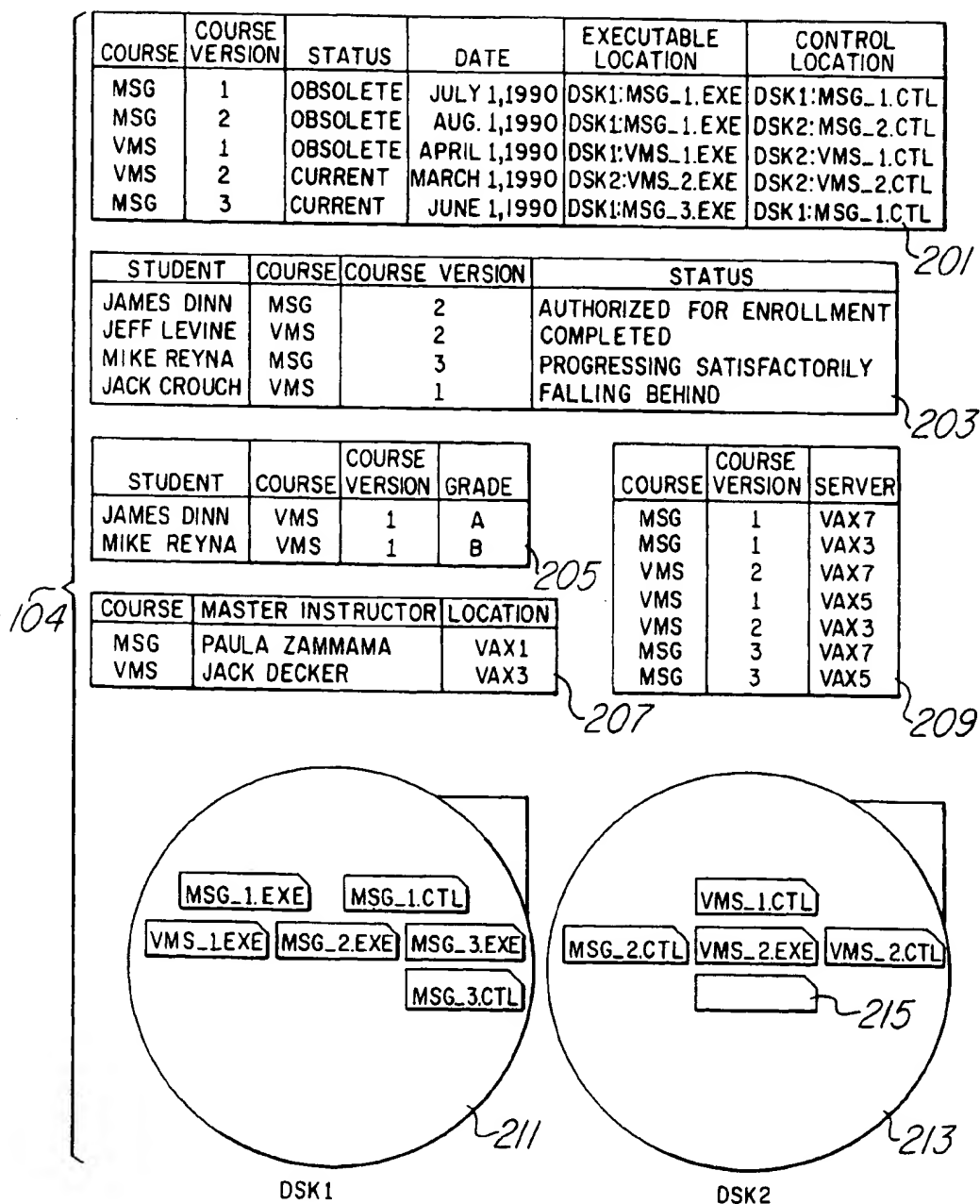
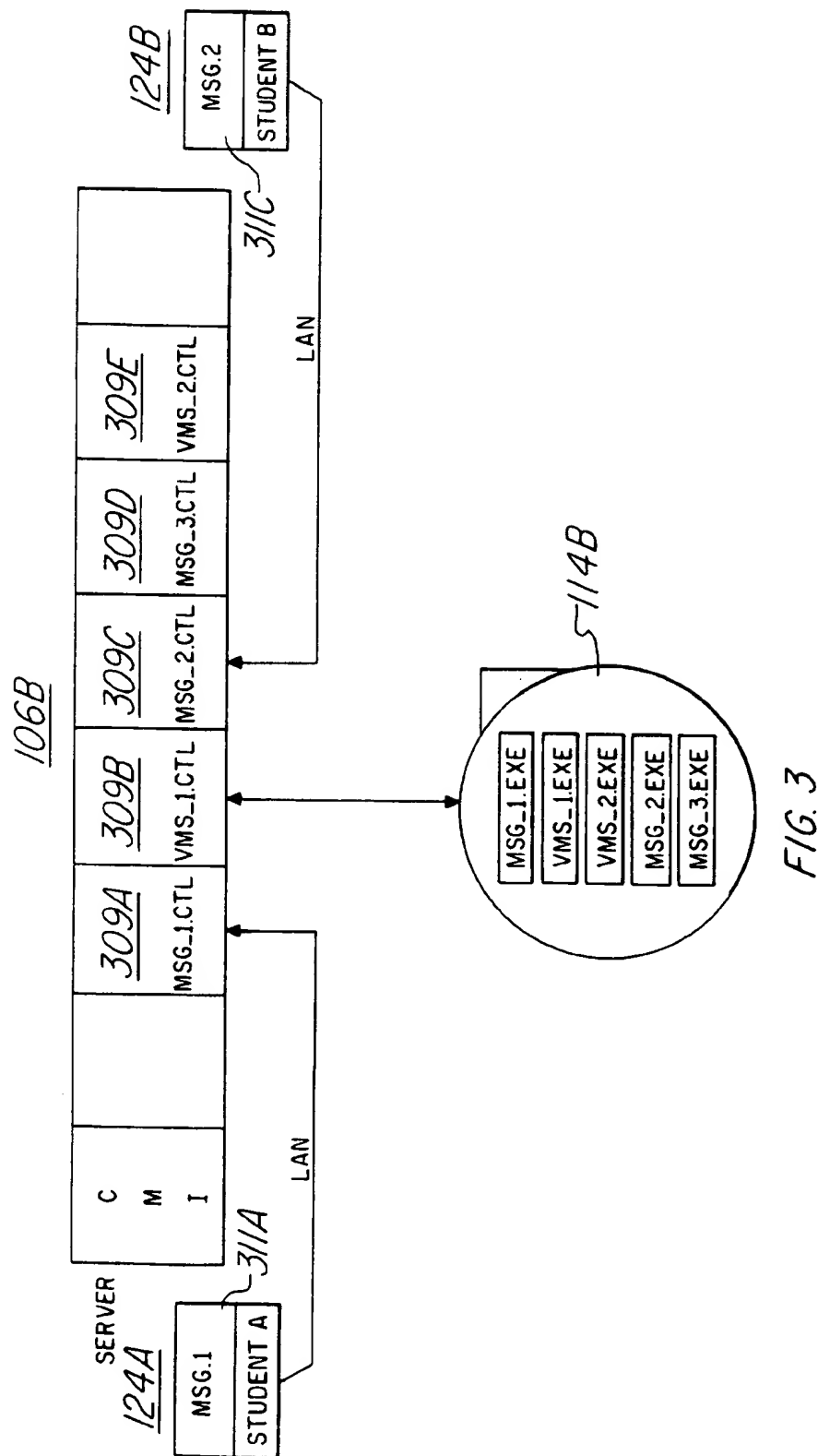


FIG. 2



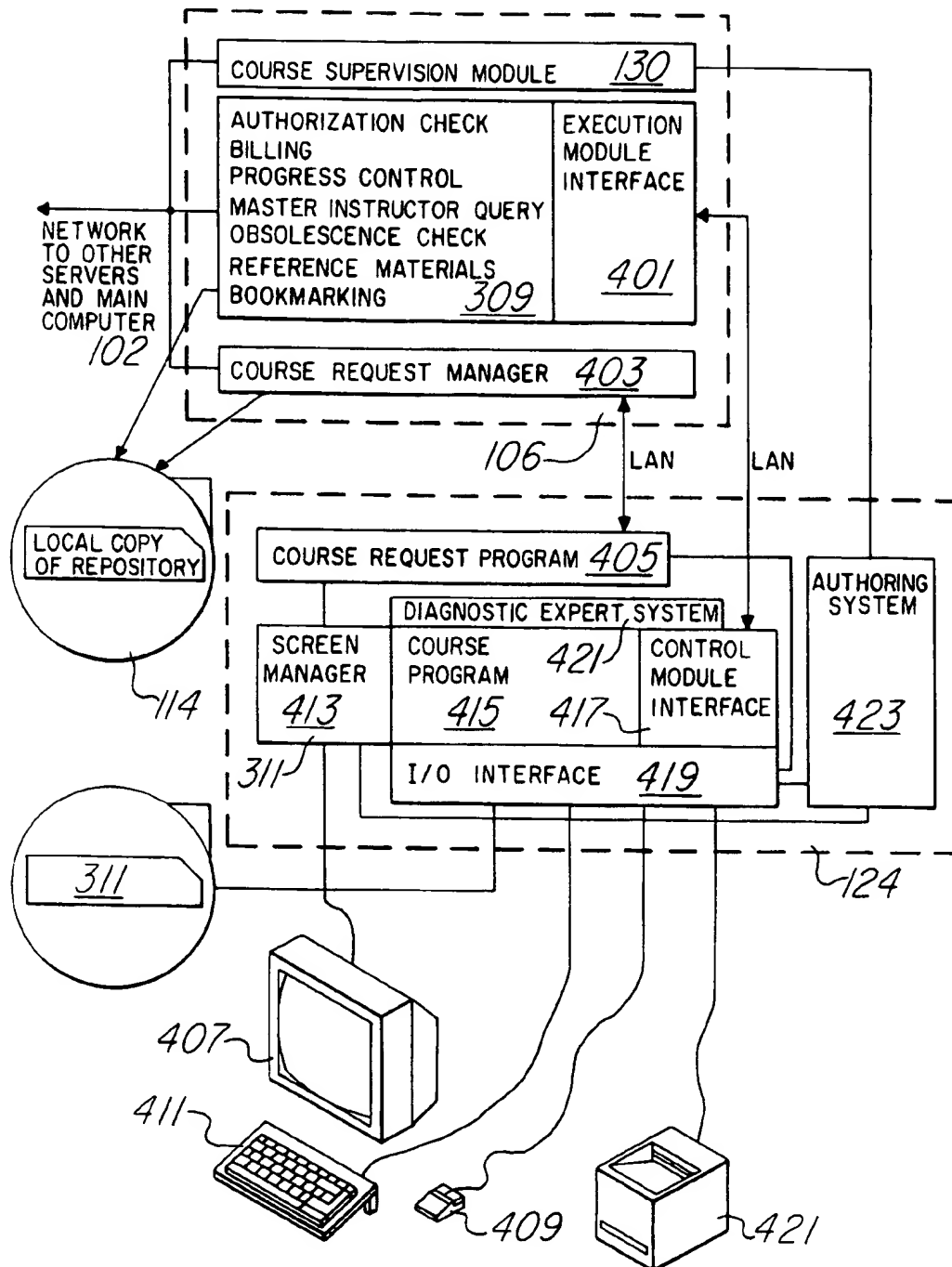


FIG. 4

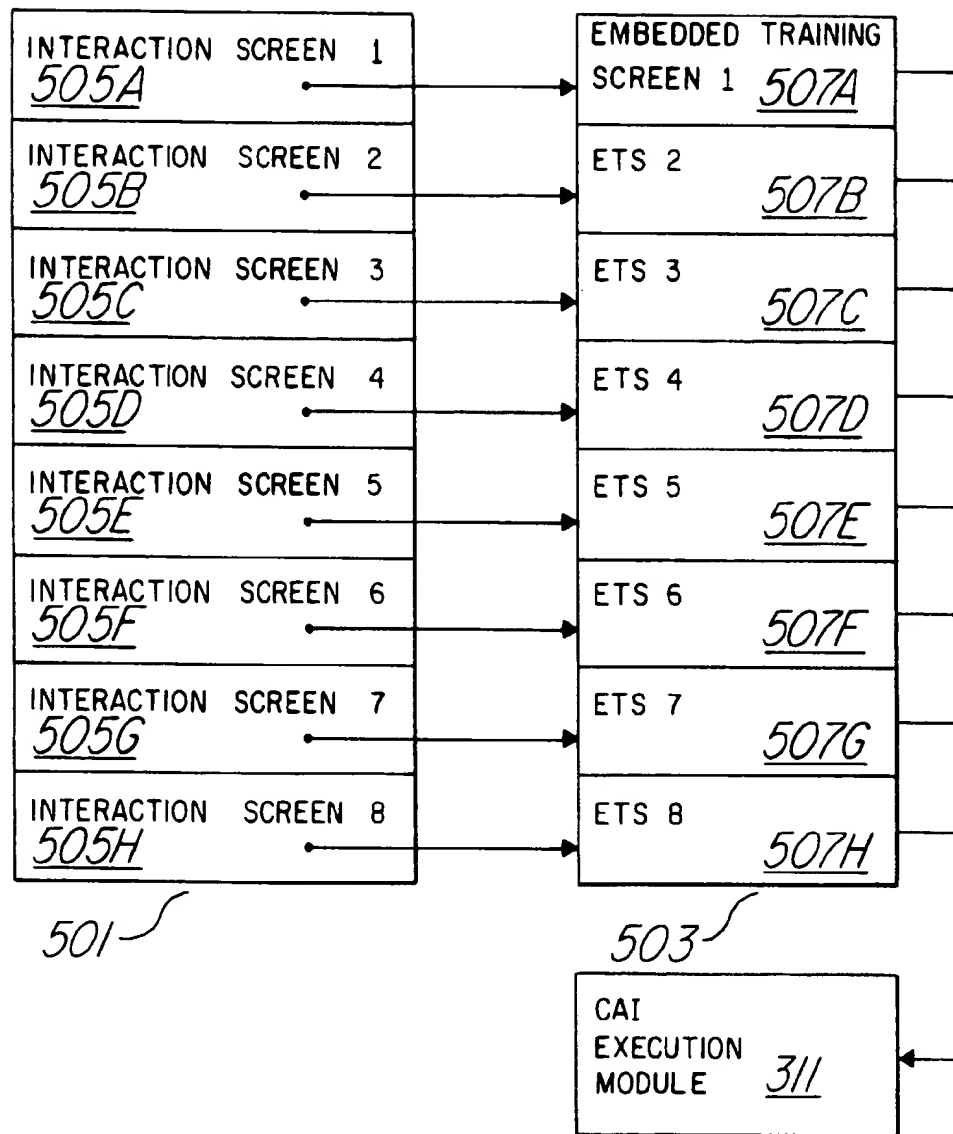


FIG. 5

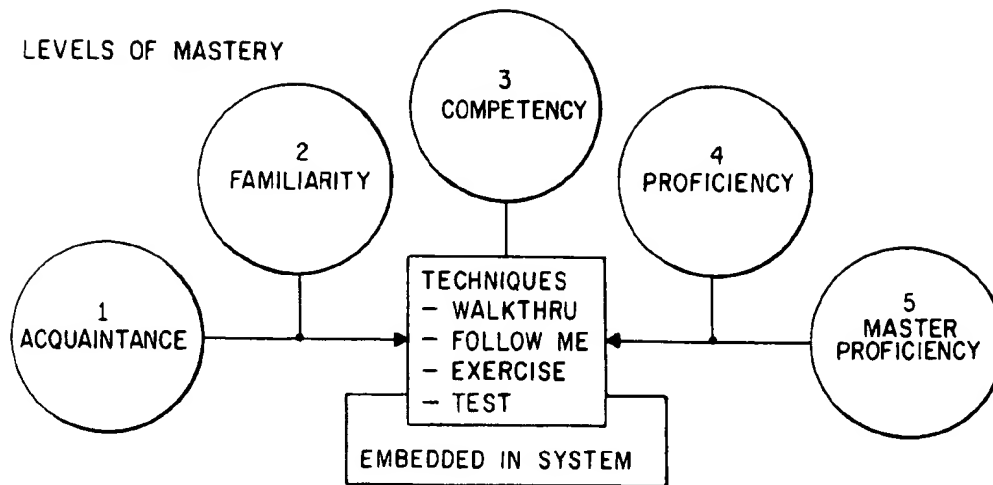


FIG. 6

RULE	<u>801</u>	GOTO	<u>803</u>	ADDRESS	<u>805</u>
ON SCREEN 10 AND INCORRECT ANSWER TO QUERY 2 REPEATED 5 TIMES		SCREEN 27		AF00 1E08	
DOING DIRECTORY COMMAND AND REPEATEDLY ENTERS INCORRECT FILE SPECIFICATION		SCREEN 4 OF FILE SPECIFICATION		AF00 11EFF	
DOING VMS BEGINNERS COURSE AND HAS ANSWERED THE LAST 20 QUESTIONS CORRECTLY		GOTO SCREEN 1 OF INTERMEDIATE COURSE		AF01 00E5	

FIG. 8



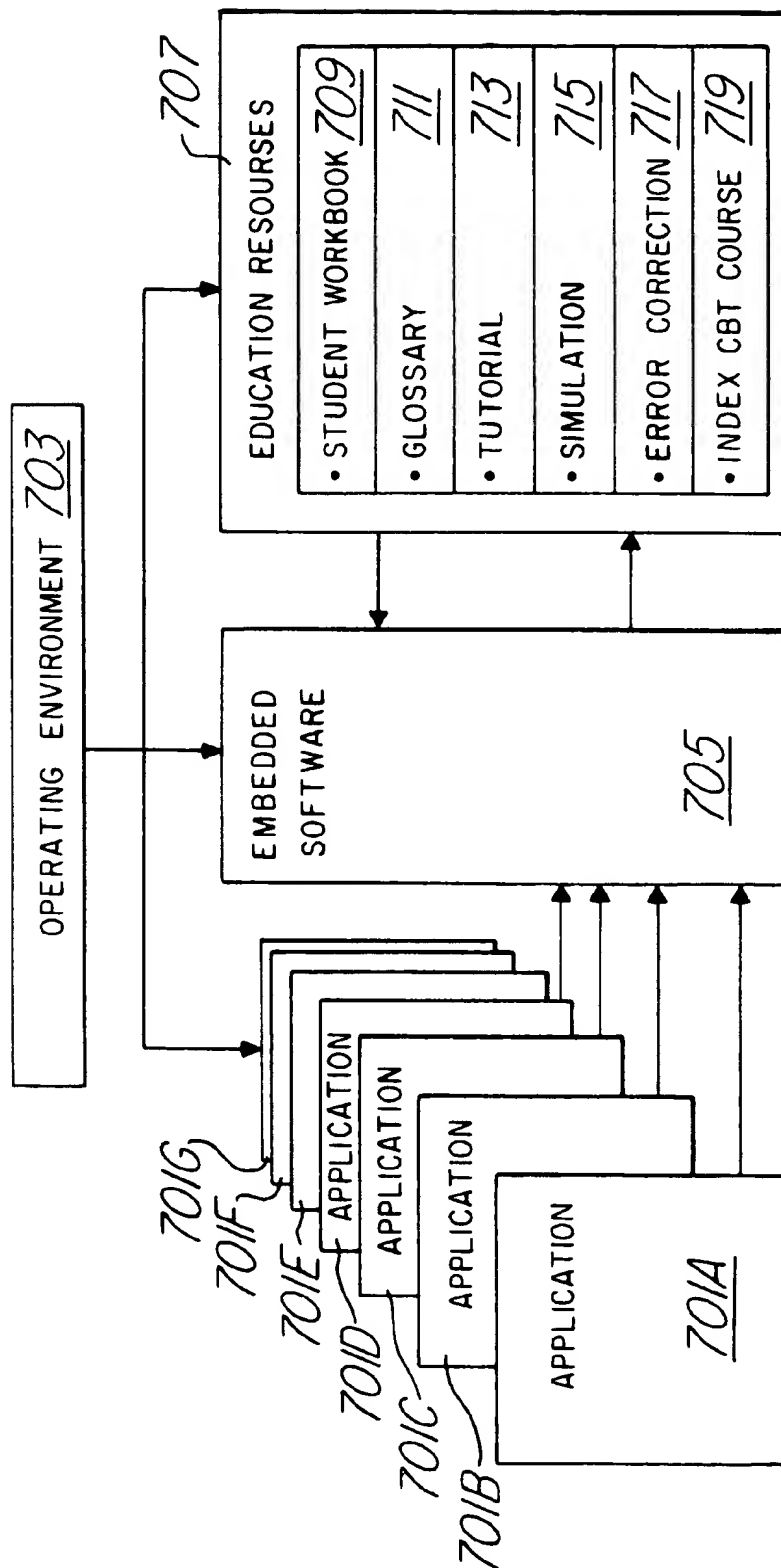


FIG. 7

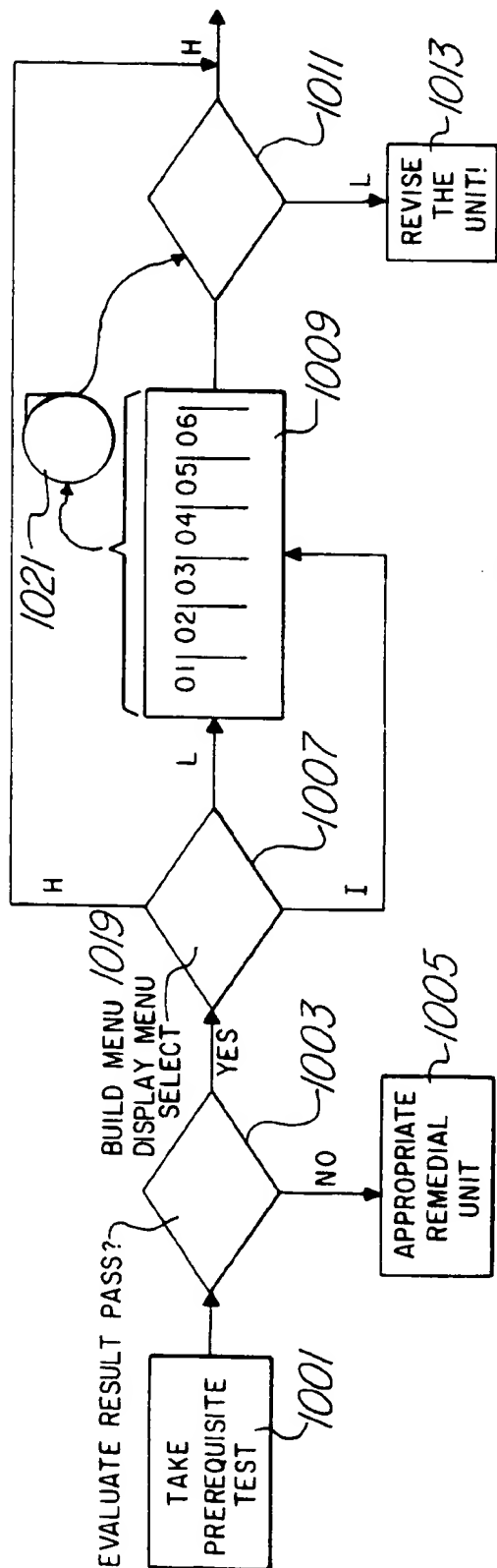


FIG. 9(a)

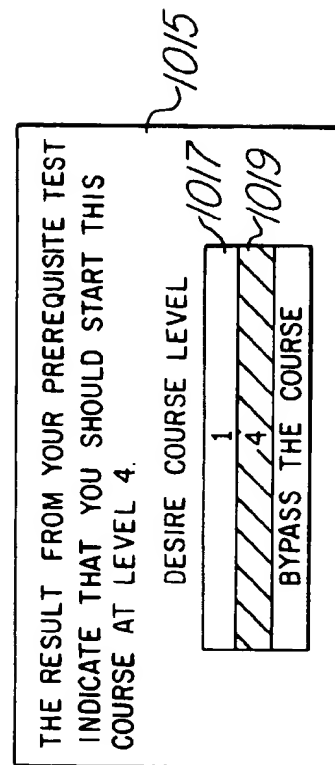


FIG. 9(b)

FILE COURSE NAME
<p>AUTHORING SYSTEM</p> <p>EDIT COURSE MENU</p> <p>(PRESS APPROPRIATE LETTER TO ENTER DESIRED MENU)</p> <p>'A' ADD A NEW FRAME</p> <p>'E' EDIT EXISTING FRAME</p> <p>'M' MODIFY PHYSICAL FRAME PARAMETERS</p> <p>'I' INTERACTIVE VIDEO/SPEECH</p> <p>'D' DELETE A FRAME</p> <p>'P' PRINT FRAMES</p> <p>'C' COPY FRAMES</p> <p>'R' RUN TRAINING PACKAGE</p> <p>'X' EXIT TRAINING PACKAGE</p>

FIG. 10(b)

<p>AUTHORING SYSTEM</p> <p>MAIN MENU</p> <p>1) CREATE NEW COURSE</p> <p>2) EDIT COURSE</p> <p>3) DELETE COURSE</p> <p>4) EXIT MAIN MENU</p>
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FIG. 10(a)

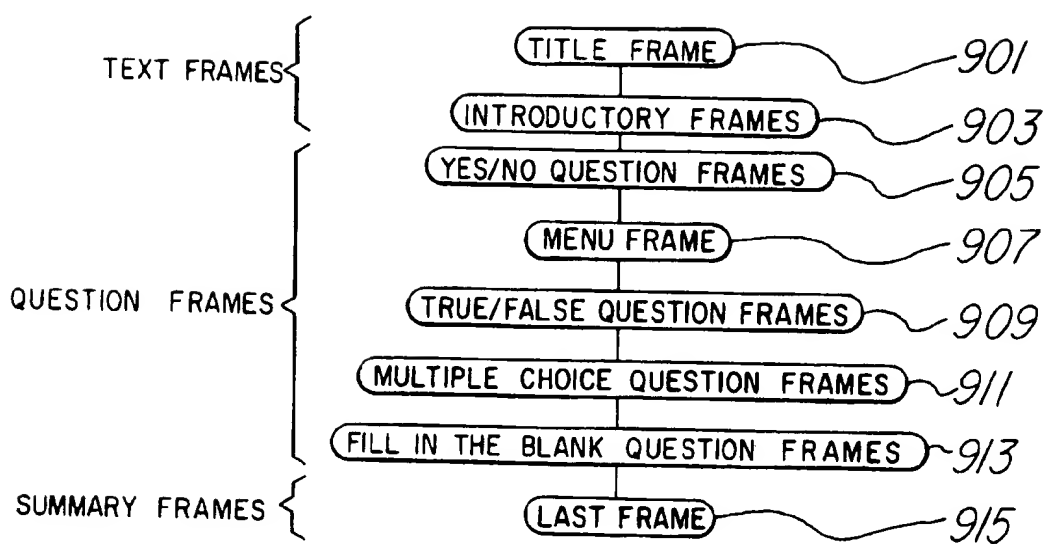
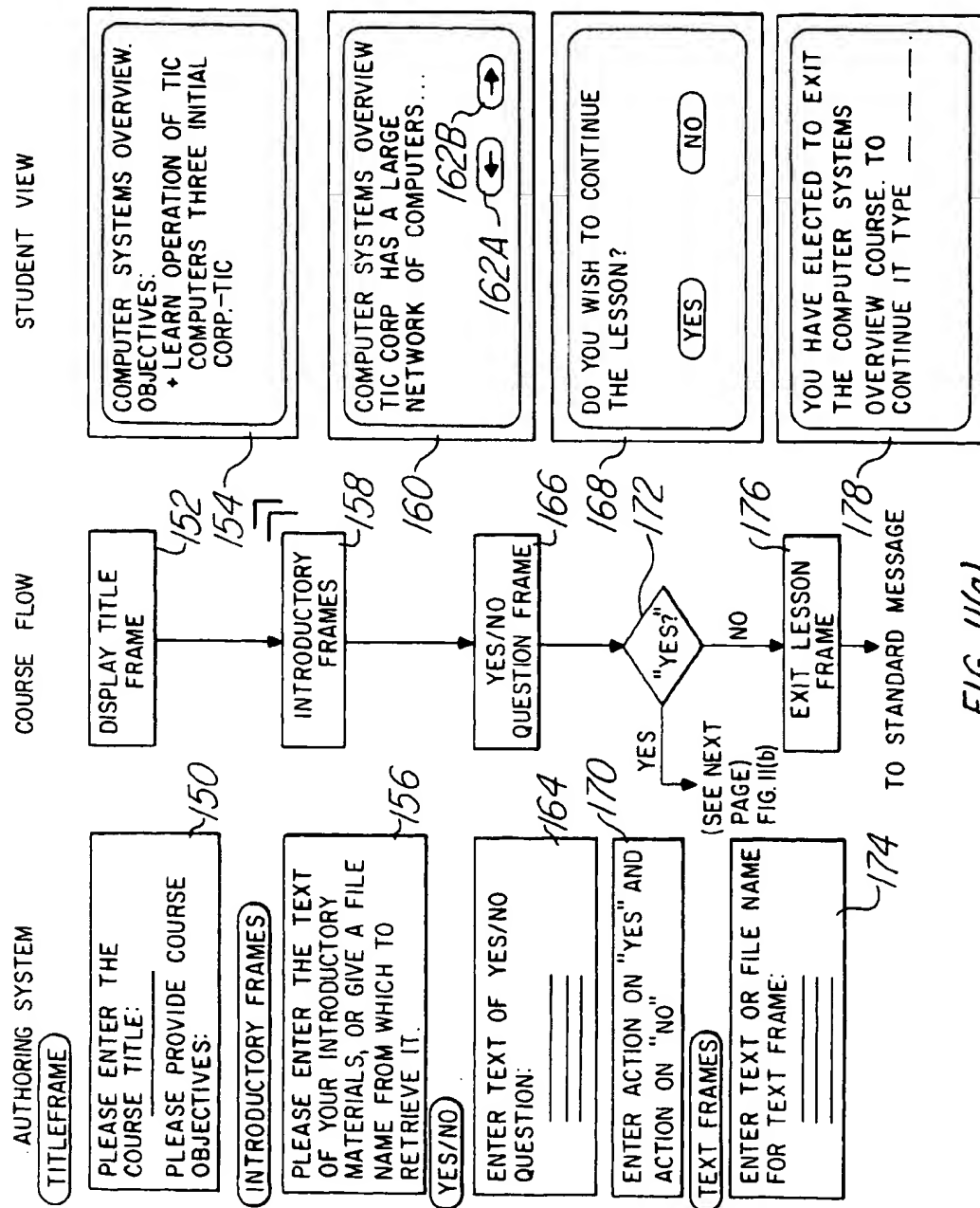


FIG. 10(c)



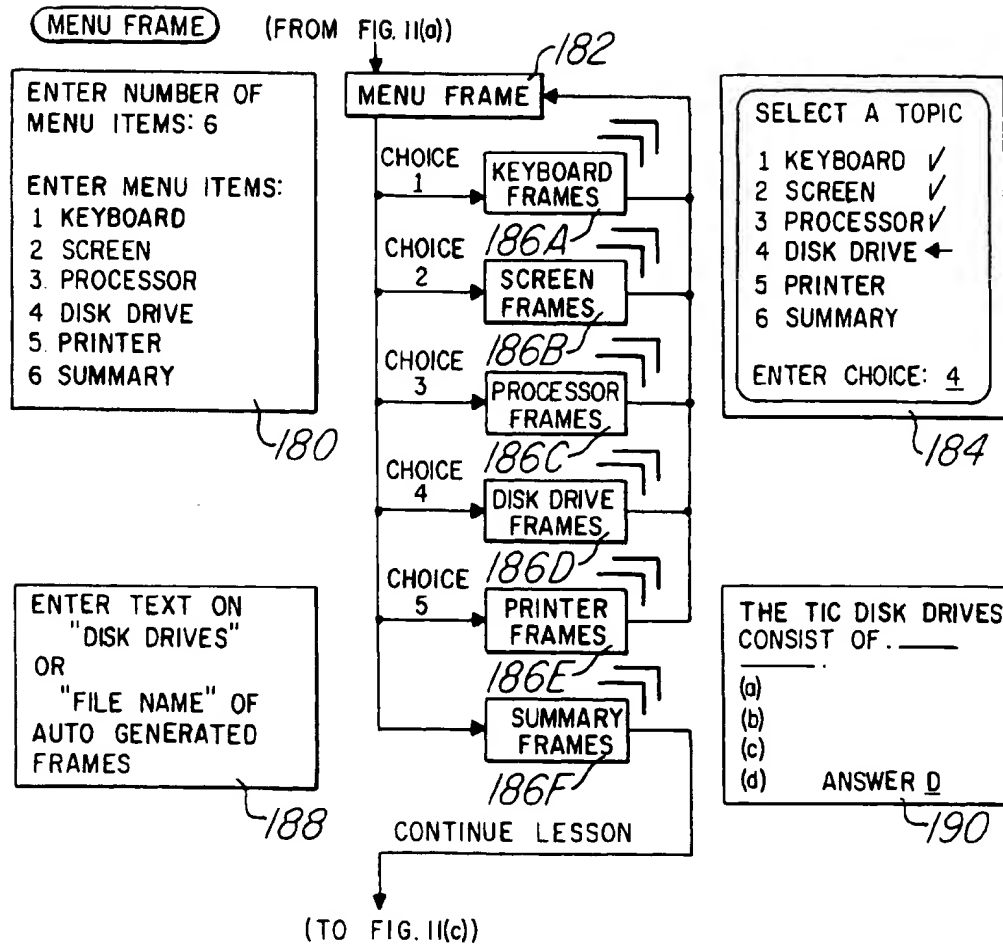
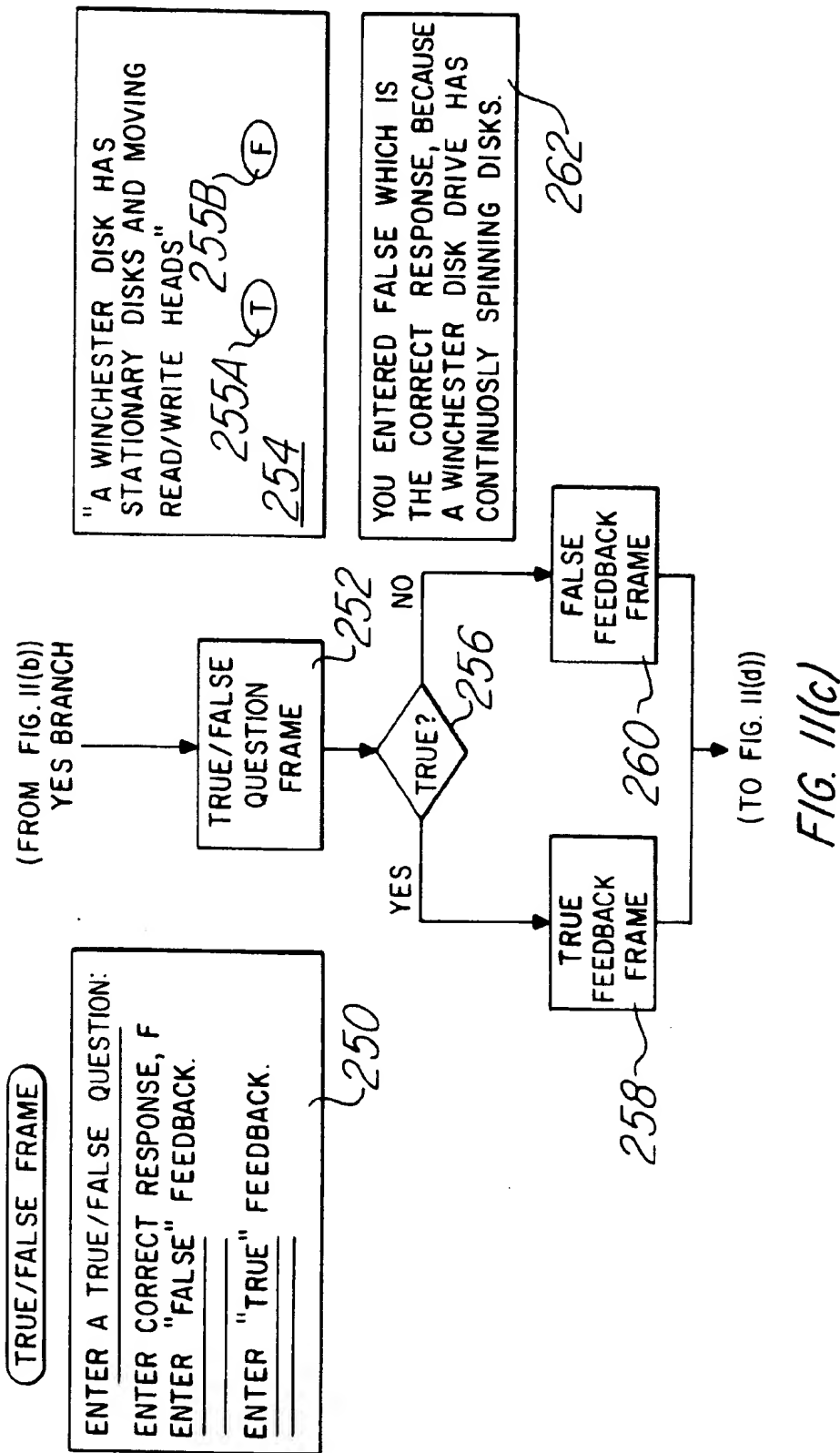


FIG. 11(b)



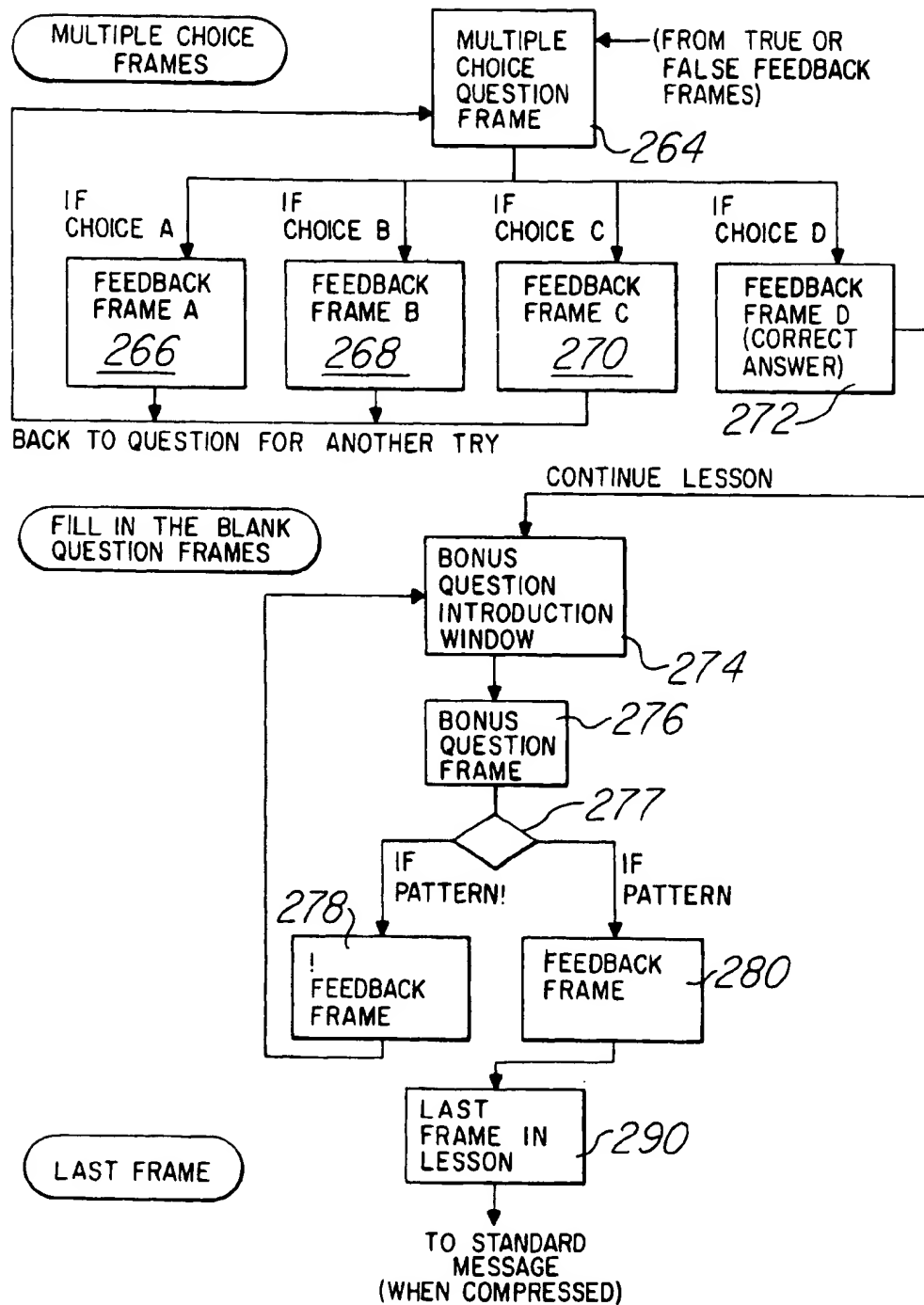


FIG. 11(d)



# SYSTEM AND METHOD FOR THE DELIVERY, AUTHORIZING, AND MANAGEMENT OF COURSEWARE OVER A COMPUTER NETWORK

This is a Continuation of application Ser. No. 07/742, 974, filed Aug. 9, 1991, pending.

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## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

This invention relates to computer aided instruction and in particular to a system and method for delivery, authoring, and management of courseware over a computer network.

### 2. Description of the Related Art

Hitherto Computer Aided Instruction (CAI) has followed two approaches, which may be labelled "the mainframe approach" and "the diskette delivery approach", respectively. Inherent to both are certain problems which make them unattractive for authoring and maintenance of educational materials, e.g., course authoring, course maintenance and course management.

In "the mainframe approach" of CAI the computerized course is a computer program stored and executed on a mainframe computer. This approach requires that each student of a particular course has access to the computer on which the program corresponding to the course resides. However, in many organizations it is not possible for all potential students to have access to a particular mainframe. Another limitation of the "mainframe approach" is that downtime affects all users. Furthermore, if the mainframe computer used for many concurrent tasks, e.g., many students taking many courses simultaneously or the CAI running in parallel with other tasks, then the responsiveness is often impaired. This aspect of "the mainframe approach" negatively effects the quality of the interaction between the courseware and the students.

In the "diskette delivery" approach, courses are delivered on a diskette and are executed by the student on his or her personal workstation. A problem with this approach is that the education administrator loses control over the course. For example, the original recipient of the course diskette may make a copy of the course and give this copy to a colleague without notifying the course administrator. Moreover, the course administrator is unable to monitor student progress and verifying that a student who enrolls in a course actually takes and eventually completes the course.

Losing control over the diskette also results in the course administrator losing control over which version of a course a student is taking. For example, if the student who originally obtains a given course, after finishing it, passes it on to a colleague and in the meantime a new update or a corrected course is released, the colleague would be taking an obsolete version. In case there are problems, e.g., bugs, in the software which constitutes a course, not being able to control which versions are actually used is a serious problem.

Another aspect of computerized training is help facilities, which provide a documentation support to computer programs. These facilities feature a "current screen" oriented user interface. The problems with this approach to training is that a user must both know that he or she has a problem and must know where to look for documentation on the problem.

Furthermore, such systems are limited to being help facilities as opposed to providing user training. Prior art training systems are stand alone programs, which are separate from the application programs to which they provide training. These systems require the user to leave the application program in order to enter the training sequence.

Another problem with prior art training systems is that there is no correlation between the mistakes a user makes in operating a system and the training provided to the user. It is required of the user to know when he or she is making a mistake, and upon realizing a mistake is being made, the user must know where to look for training materials.

Accordingly, improvements which overcome any or all of these problems with existing Computer Aided Training systems are presently desirable.

## SUMMARY OF THE INVENTION

A network system for computer aided instruction, comprises a main computer with a repository for storing courseware, a network of servers connected to the main computer, a number of local area networks, each connected to a server, and each comprising a number of interconnected workstations. In this network a distributed delivery system is responsive to a student's request for a course and is operable to search the network for a server where the requested course resides. If the course is not resident on any server the delivery system operates to retrieve the course from the repository.

The network computer aided training system also incorporates a course management system, which also is distributed over the network. It is operable to manage course enrollment and to monitor student performance at the servers and to transfer information concerning course enrollment from the servers to the repository at the main computer.

The network system also has an authoring system which is distributed over the workstation, the servers and the main computer, and is operable to transfer courses from a workstation where the course author works to the repository. The authoring system also provides the course author with tools for automatically generating templates for courses from interviews with subject matter experts and tools for creating various types of interaction screens.

Courses are developed to provide multiple levels of detail ranging from an overview of the subject matter to a high level of detail and comprehensive testing. There are also intermediate levels, for example, one in which detailed information is provided but testing only occurs at the end of each lesson and a relatively low score is considered as "passing."

In one aspect of the invention, computer programs have provisions for training users in its use, comprises application code, hook points connected to the application code, and embedded training routines connected to the hook points, so that there is a mapping between the hook points and the embedded training routines. The application code has code responsive to a user action to transfer control from the hook points to the embedded training routines. Furthermore, the embedded training routines are operable to transfer control to courses which provide a higher level of detail.

It is an object of the invention to manage courseware in a non-exclusive fashion both at a central repository and at servers located throughout a computer network.

It is another object of the invention to enable a student working at a workstation located anywhere in the computer network to request enrollment in courses which may or may not be located at a server connected to the student's workstation.

It is an additional object of the invention to manage the enrollment and to monitor the performance of a student at the server to which the student's workstation is attached, and to transfer the enrollment and performance information from the server to a main repository.

It is a further object of the invention to embed training materials into application programs while allowing the training materials to be located at any server or repository in the network.

It is also an object of the invention to enable course authors to transfer new courses and updates to old courses from their individual workstations into a main repository for courseware from which students may retrieve the courses.

It is an additional object of the invention to allow course managers to be privy to information concerning the courses they manage, e.g., questions which appear to be defective, so that they can use that information in updating the courses which they manage.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a computer network environment in which the invention operates.

FIG. 2 is a database schema and file structure for the preferred embodiment of the networked computer aided instruction system.

FIG. 3 shows the programs operating on a server and two workstations according to the preferred embodiment computer aided instruction system.

FIG. 4 shows internal details of the programs operating on a server and a workstation according to the preferred embodiment.

FIG. 5 shows the preferred embodiment embedded training program.

FIG. 6 shows features of the networked computer aided instruction and embedded training according to the preferred embodiment.

FIG. 7 shows how certain modules of the embedded training according to the preferred embodiment are shared between application programs.

FIG. 8 shows the rule base for the diagnostic expert system of the present invention.

FIGS. 9(a) and 9(b) show the branching options available to a student taking a course implemented according to the preferred embodiment.

FIGS. 10(a), 10(b) and 10(c) show the main menus of the course authoring system of the present invention.

FIGS. 11(a), 11(b), 11(c), and 11(d) show the interaction between the author and the authoring system, the structure of a course created using the authoring system, and the student's view of the course, all according to the preferred embodiment of the invention.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1 is a block diagram of a computer network environment in which the invention operates. In FIG. 1, a main

computer 102 is part of a computer network 100. Repository 104 is connected to main computer 102. Computer network 100 also consists of a large number of servers, for example servers 106A, 106B, and 106C. Each server may have associated with it some file storage, e.g., disks 114A and 114B. The servers are connected to and "serve" local area networks (LAN) 120. These LANs consist of interconnected workstations, e.g., workstations 124A, 124B, and 124C. Workstations, e.g., 124D, 124E, and 124F, may also be connected directly to main computer 102. In FIG. 1, each small circle designates a workstation. In an alternative embodiment, some servers are peer servers, i.e., they are workstations in the same LAN as the workstations they serve.

Typical to large organizations, such as corporations, universities and government agencies, is that computer networks, such as the one depicted in FIG. 1, consists of hundreds or thousands of computers. These computers may be connected in a myriad of different ways. FIG. 1 shows only one way in which the relatively small number of computers shown there can be connected. A person of ordinary skills in the art will realize that the present invention is in no way dependent on the number of computers in the network or how these computers are connected to one another.

Another typical feature of computer networks is that the types of computers in the network varies widely. Therefore, it is of primordial importance that the computers, which are of differing manufacture, may communicate with each other, and any software products which rely on distributing tasks over the various computers in the network should be so constructed as to make the differences between the various kinds of computers in the network moot. The present invention is cognizant of these problems inherent to computer networks with multiple types of computers.

From the network point of view, main computer 102 may be no different than any other computer in the network. However, from the perspective of the present invention, main computer 102 serves the designated function of managing a central repository 104 of courseware. FIG. 2 is a schematic of repository 104. It shows a relational database implementation of the database in which course and student information is stored. The repository 104 can be implemented using other database technology, such as those based on the entity-relationship model, the hierarchical model, and the network model.

In the network environment of FIG. 1, repository 104 is distributed over the computers that constitute the network. Certain redundant information is kept in the servers, so that in the event that part of the network is down, then the information which goes into the repository can be held in a server. Similarly, courses may be stored on multiple servers so that access to a given version of a course is possible without accessing the central repository 104. Periodically, the distributed database is verified with respect to the information held in the central repository 104, so as to assure that no inconsistent information is held by any of the servers. The verification process comprehends updating, at all sites in the network, the programs which are implementations of courses, and the databases which store enrollment information, charges for courses, and locations for course versions.

A student working on a workstation 124 requests a course. This prompts two actions from the server 106 attached to the LAN which the workstation is attached. The first action is to check whether the student is authorized for taking the

*any network*

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course. If the student has been authorized to enroll, the second action, searching for the course, commences. Searching for the course entails first looking in the local copy of the repository to see if the current version of the course is resident on the server. If it is not, the network is searched. In the preferred embodiment of the invention the server sends queries to the other servers 106 in the network 100, asking for the course. If a queried server has the course, it replies to querying server with the location of the course. If the queried server does not have the course, it passes the query on to all other servers, unless it recognizes the query as being one which it has already passed on to other servers, in which case the queried server does nothing.

The search for a course eventually leads to the main computer 102. All courses are stored in the repository 104, therefore, the query can be satisfied. The appropriate reply is sent back to the requesting server.

Because the search may go through several paths in the network, it is possible that more than one server replies with the location of the course. For that reason, the number of links which the course must pass through, and the transaction cost associated with each link is computed as the reply makes its way back to the requesting computer. The requesting computer uses this information to decide from which server it can most expeditiously and inexpensively copy the course. It then requests that the course be copied to its file storage. At the same time, the information that the course is being copied to the requesting server is sent to the main computer 102 so that repository 104 can be updated.

FIG. 3 shows the programs operating on a server 106 and two workstations 124 according to the preferred embodiment computer aided instruction system. When a student requests a course it is not copied beyond the server 106 which serves the LAN to which the student is connected. The student's workstation merely receives an execution module 311 for the course. This execution module 311 interacts with a course control module 309 in the server. FIG. 3. shows this architecture. Student A, on workstation 124A, executes execution module MSG\_1.EXE (311A). The corresponding control module MSG\_1.CTL (309A) executes on server 106. These two modules communicate via the LAN that connects the workstation 124A to the server 106. Similarly, student B, on workstation 124B, executes execution module MSG\_2.EXE (311C), which in turn communicates with control module MSG\_2.CTL (309C), on server 106.

Thus, by giving the student access to the execution module 311 of a course does not give up control of the course. The course control module 309 is never down loaded beyond the server level. Thereby making it impossible for a student to make copies of a course and distribute it to colleagues. In the event a copy is made of the execution module 311 of a course and that module is executed on another workstation, it will try to access the corresponding control module 309 on a server, which in turn would be able to do the requisite course management.

Server 106B also has connected to it file storage 114B which contains the execution modules for the various courses resident on server 106B. The purpose of storing the execution modules on the server is two fold: first, so that the execution module can be down loaded to the workstations connected to the server, and, second, so that if another server requests a course, both the execution module and the control module for that course can be copied to the requesting server.

FIG. 4 shows more detail of the programs resident on each server 106 and each workstation 124. On the servers 106 a

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course request manager 403 responds to course requests made on workstation 124 by means of a course request program 405. The workstation 124 is connected to a CRT 407, a keyboard 411, and a mouse 409. A student operating workstation 124 interacts with the programs resident on workstation 124 using devices 407, 409 and 411. In the operating system controlling the workstation (e.g., DOS or UNIX) there are ways for invoking the course request program 405. The course request program 405 may interact with the student using a menu oriented interface or by accepting commands typed on keyboard 411. When the course request program 405 obtains a course request from a student it sends a message to server 106, in particular to the course request manager 403. The course request manager 403 then checks the local repository to determine if the student is authorized for the course and if the course is resident on the server 106. If the authorization is not found on the server, then course request manager 403 sends a message to the main computer 102 via the network 100. Similarly, if the course is not found on server 106, course request manager 403 initiates a search, as described above.

The course execution modules 311, are resident on workstations 124, and consist of screen manager 413, a course program 415, a control module interface 417, and an input/output interface 419. The course program 415 is the kernel of the course execution module 311. It contains, in computer executable form, the educational material taught through the course. The course program 415 interacts with screen 407 via screen manager 413, and with printer 421, keyboard 411 and mouse 409 via input/output interface 419. Course program 415 interacts with course control module 309 through control module interface 417. Control module interface 417 sends messages over the LAN to the execution module interface 401 of course control module 309.

Each course control module 309 contains an execution module interface 401. The role of the interface is to receive and send messages to the execution module 311 corresponding to the control module. Furthermore, each course control module 309 for a course contains an authorization check procedure, a billing procedure, a progress control procedure, a master instructor query procedure, an obsolescence check procedure, a reference materials procedure, and a bookmarking procedure. Each of these procedures may access the network by sending messages to other servers 106 and to the main computer 102. These procedures also access the local version of the repository, thereby making it possible for the course management on the main computer 102 to access the databases on the various servers 106 to update student progress and course enrollment.

An additional advantage of splitting a course into a control module 309 and an execution module 311 is that certain portions of a course may be retained on the servers 106, thereby freeing disk resources on the workstations 124 and facilitating course maintenance. For example, if a course is found to have a defective routine, and that routine is located on the servers 106 rather than on the workstations 124, then it is possible to replace the routine without changing the portions of the course resident on workstations 124. This is advantageous because typically there is no central control over the software resident on individual workstations 124.

Course control module 309 contains a bookmarking facility. This is a procedure which is responsive to a message from a student that he or she wishes to take an extended pause from the course but return to it at the exact current state. In other words, the student's location in the course and the current results are saved into a bookmark file. This file

is stored on the file storage device of the server. In an alternative embodiment the bookmark file is created on the workstation and saved on the workstation's file storage.

Returning to FIG. 2, relation (also known as table) 201 contains the status of each course. As courses are updated older versions of the courses become obsolete. The status column is used to store information about which courses are current and which are obsolete. The date column serves a dual purpose, namely, for current courses it indicates when that version became the current version, and for obsolete versions, the date column indicates when the course will no longer be available. As can be inferred from FIG. 3, an obsolete course may remain available after it has become obsolete, so as to allow students to complete the same version of a course as the version in which they started the course. However, after a predetermined obsolescence period the course is made unavailable, regardless of whether certain students have yet to complete it.

Relation 201 is also a store for information on where to find local versions of the courses. The "executable location" column gives a disk address where the executable module for a course is located and the "control location" column gives the corresponding location for the control module. The actual programs which make up a course are located on disk drives 211 and 213.

Relation 203 is a store of the students' status information with respect to relevant courses. Examples of status are "authorized for enrollment", "completed", "dropped out", "falling behind", "progressing satisfactorily", and "pausing". Relation 205 is a store for students' grades. Relation 207 contains a list of "master instructors" for all courses. A master instructor is a person with particular skills relevant to particular courses. If a student on a workstation 122 has a problem with understanding a course the student can invoke a special query procedure which retrieves the master instructor's name and network address, and allows the student to send a message to the master instructor. This message contains the student's name and network address so that the master instructor can respond to the question.

For maintenance purposes and to facilitate locating courses, relation 209 contains a list of all servers where the various courses reside. Thus, if a course becomes obsolete, a message may be sent from the main computer to all servers which have that particular course resident, so that the servers may make the course unavailable on the obsolescence date.

Resident on main computer 102, of FIG. 1, is a supervisory program 128 responsible for maintenance of repository 104. One task of supervisory program 128 is the automatic archiving of the database tables in repository 104. Tables 201 through 209 continuously grow as new courses are added, old courses become obsolete, students enroll, and students finish courses, etc. When the tables become very large performance of the system degenerates. Therefore, information about obsolete courses is removed periodically, e.g., once a week or once a month. When information is removed from the tables, it is moved into one or more archival files 215. Supervisory program 128 also contains code to recover information from archival files 215. A similar maintenance task is done on the various servers 106 by programs 130A-130C, respectively, i.e., moving information about obsolete courses from the database tables resident on the server into archival files, also resident on the server. These archival tasks are automatically triggered to occur at specific times or by specific events, e.g., a certain number of course versions have become obsolete or the number of students who have completed courses reaches a specified number.

Supervisory module 128 also provides on-line maintenance of the programs and databases supporting enrollments, charges for courses, and locations of course versions across the network.

The network 100 in FIG. 1 also contains provisions for uploading courses from workstations located anywhere in the network to the central repository 104. A course author may be located on any workstation and send a message to main computer 102 that a new version or a new course has been completed. The main computer 102 would then initiate moving the executable module and the control module for that course into disk drives 211 and 213 and update relations 201, 207, and 209, as appropriate and as approved by the curriculum advisory authority.

The courseware according to the present invention incorporates several features which improve student interest. For example, interaction with the courses and course management software is menu driven and icon based. The courses are implemented so that a student can request animation and simulation of the material covered in the course, as provided by the course author. Furthermore, the courseware incorporates interfaces to video material. In other words, a student taking a course on the assembly of a computer can request that certain steps be shown through video and that other steps be simulated using on-screen graphics and animation. In an alternative embodiment, these features are automatically executed when the student takes the course.

Returning to FIG. 4, the courseware according to the present invention includes a diagnostic expert system 421 which runs in the background of the course. The diagnostic expert system 421 is privy to all transactions between the student and the course. Using built in rules it directs the student through the course. If the student has particular difficulty with one subject area, the diagnostic expert system 421 increases the level of detail of the instruction in that subject area. On the other hand, if the student excels, the diagnostic expert system allows the student to progress through the course at a higher pace. The diagnostic expert system 421 analyzes the student's responses to questions to determine for which areas the student requires training. The diagnostic expert system 421 is a series of hook-points to particular addresses in the machine code implementation of the course. Using rules based on particular student responses, or on incorrect responses, the diagnostic expert system 421 directs the student to the appropriate training screens.

Also resident on servers 124 is an authoring system. The authoring system 124 provides an intelligent environment in which a course author creates courses. In the artificial intelligence domain of expert systems, a human expert is interviewed by a knowledge engineer, who builds an expert system. In the authoring system, templates for course screens are automatically derived from the expert interview.

Furthermore, the authoring system 124 incorporates an editing facility which allows for global search and replace of text strings, graphic images, etc. for entire course.

The authoring system 124 also provides a mechanism to allow authors to put string variable operations into courses. For example, in a VMS operating system course, a possible question is "Type an example of a directory command which lists all Pascal files created today." Several correct replies are possible, e.g., "\$ DIR/SINCE \*.PAS", "\$ DIRECTORY \*.PAS/SINCE", and "\$ DIR/SINCE=TODAY [ ]\*.PAS". Any of these replies should be considered a correct response. Similarly, the authoring system provides a mathematical function interface, wherein a student replies to questions

using mathematical functions rather than by giving exact numbers. An example from electrical circuit theory is a problem to calculate the current through a particular resistor in a circuit. The answer to that question can be described in terms of Ohm's and Kirchhoff's laws rather than by giving the exact numerical value.

Related to the networked computer aided instruction system of the preferred embodiment is embedded training. In this aspect of the preferred embodiment the training is incorporated into the various computer programs executing on a workstation. This is illustrated in FIG. 5. Application program 501 is a screen oriented program. It is composed of eight interaction screens 505A-505H. Each interaction has a "hook point" to which is linked an embedded training screen 507A-507H. Through some action of the user of the application program, e.g., pressing a help button, the embedded training screen is invoked. The embedded training would be particularly pertinent to the screen from which it was invoked. Typically, the student is allowed 30 seconds to three minutes for completing the embedded training for a particular topic. However, if the student does not learn sufficient detail from the embedded training, then he or she may transfer directly from the embedded training to the computer aided instruction course 311 associated with the application program.

FIG. 6 shows two key features of the preferred embodiment. First, in the preferred embodiment courses are implemented for multiple levels of detail. In a university environment there is a distinct level of detail required by the University President who merely wants to know what the various offered courses teach, and the student who is trying to master a subject. Accordingly, in the preferred embodiment courses are developed for five different levels: Acquaintance, Familiarity, Competency, Proficiency, and Master Proficient. When a student invokes a course, the course queries the student as to what level he or she wishes to enroll.

The "Acquaintance" level is a high level overview of the subject matter of the course with no detail attached, e.g., looking at the objectives covering each lesson. The "Familiarity" level gives the student the ability to page through a course while reviewing detail information without having to respond to questions. The student also has the ability to branch to chapters or sections within a chapter. In the "Competency" level a student is presented material that will be test at the end of each lesson. The student must attain a specified passing score, e.g., seventy, in order to be certified as competent on the subject matter. The passing score indicates that the student is qualified to perform the tasks reviewed in the subject matter presented.

In the "Proficiency" level the student is first pretested to record the student's level of proficiency prior to taking the course. The student must pass any prerequisite course or topics required before enrolling into the course. Upon satisfying the prerequisite test the student is presented materials in which question and answer dialogues are continued throughout the course delivered to the student. The student must respond to multiple questions within the text delivered as well as pass a thorough test at the end of each lesson. Finally, the "Master Proficiency" level requires not only a prerequisite test as a requirement for enrollment but upon completion of the course, the student must be able to critique material given and append their knowledge to the topics covered by the course. After all tests are completed the student must maintain a high score, e.g., at least 90, for the entire course in order to be judged master proficient.

Furthermore, the courses are developed so as to give the student multiple options in terms of testing competency.

First, the courses implement walk-throughs, in which students are guided through the procedure being taught by the course. A second technique is "Follow me" in which the course simulates the task that the student wishes to learn. Courses also implement exercises. These serve the dual purpose of giving the student some knowledge about his or her own progress and of giving the course administrators a means of monitoring student progress. In some courses the student may be required to complete a certain number of exercises in a given time unit, e.g., one set per week. If the student fails to meet this requirement, the course sends a message to the main computer to change the student's status to "falling behind." This status gives course administration notice to let the student's management know that the student is falling behind or having some kind of problem with the course.

FIG. 7 shows more detail of the embedded training system according to the preferred embodiment. The workstation is controlled by operating environment 703. This environment controls application programs 701A-701G, the embedded training software 705, and the education resources 707. As discussed above, each application program has one or more hook points into the embedded training software. More than one application can share the same embedded training. For example, in standardized user interfaces, many applications will do file access in the same manner, therefore it is appropriate that the training software associated with file access is common for all applications which share the file management software. The embedded software accesses the education resources 707. The education resources is a centralized repository for such things as the student workbook 709, the glossary 711, the tutorials 713, simulation software 715, error correction software 717, and the Index of Computer Based Training (CBT) courses 719.

In the embedded training aspect of the present invention, the diagnostic expert system 421 serves the role of monitoring the interaction of a system user with a system, and analyzing that interaction to determine when the user needs training in a particular subject matter. For example, if the embedded training is used in conjunction with an operating system and a user is trying to copy files, but fails to do so because of incorrect file specifications, the diagnostic expert system 421 executes a training screen on how to formulate a correct file specification.

FIG. 8 shows an example of a knowledge base of rules for the diagnostic expert system. Column 801 contains specific rules and column 803 the logical location where the course should resume if the rule is true. The entries in column 803 are in terms of the goals for the transition. For example, in row 809 if a student or user has problems with file specifications, the training screen for file specifications is displayed. Column 805 contains the memory locations for the machine code implementing the training screens in column 803.

FIG. 9(a) shows the flow of control through the pre-enrollment phase of a course according to the present invention. The student may be required to take a prerequisite test, step 1001. This is a computerized or computer randomized test. The results from the test is analyzed in step 1003 to determine to which course level the student should enroll. If the student failed the test, he or she is directed to take a remedial course, step 1005. Step 1007 entails building a menu of the options available to the student in the event he or she attained a passing grade on the prerequisite test. The menu 1017, shown in screen 1015 of FIG. 9(b), is displayed to the user. The student has the options of taking all levels of the course, start at the level his or her score indicates to

be the appropriate level given the student's competence level, and to bypass the course all together. These choices are shown in menu 1017 of FIG. 9(b).

After selection of a level, the course 1009 is invoked, during which the student reads materials, views video material, and answers questions. During the execution of course 1009 a summary file 1021 is built. The summary file 1021 is used in step 1011 to analyze the questions with respect to the answers given by the student. This analysis entails highlighting questions which are repeatedly answered incorrectly, so that the course or the question can be revised. The summary files and the analysis done on every server are sent via network 100 to the course author or course manager. The course author or manager further analyzes the summary files from multiple servers to decide whether the course should be revised, and revises the course, step 1013. In the event the author or manager revises the course, he or she sends the new course version to the main computer 102, where the courseware administrator decides whether or not to include the new version into the main repository. If the course is included, the version it replaces may be made obsolete, in which case a message to that effect is sent to all servers where the course resides and to all students currently enrolled in the course.

FIG. 10(a) shows the main menu of the course authoring system. The author interacts with the main menu by selecting the number of the desired option. As indicated the author may create a new course, edit a course, or delete a course. The main menu also provides an option for exiting. The selections which the author makes causes the authoring system to display one of several alternative screens.

FIG. 10(b) shows the screen which the authoring system displays whenever the author selects the "Edit course" option. For example, the author may use the EDIT COURSE MENU, shown in FIG. 10(b), to add a new frame, edit an existing frame, change frame parameters, select an interactive video/speech frame, delete a frame, print frames, copy frames, or run the training package. A frame is a unit of course-to-student interaction. Although not required, a frame often corresponds to one screen of information. However, because there is no limitation on frame size, two or more frames may be displayed on the screen at one time. This feature is useful to display a graphic in one frame, and querying the student about the graphic through another frame.

The "add a new frame," option transfers the user into the menu shown in FIG. 10(c), which is discussed in further detail below. The "edit a frame" option gives the author the ability to edit an existing frame. Frames can exist of text and graphics. Therefore, both the "add a new frame" and the "edit a frame" options enable the author to create and edit both text and graphics. For example, the authoring system, allows the user to create lines, circles, boxes, arcs, slices, and curves, in a frame. Similarly, in terms of text manipulation, the authoring system enables the user to select from different fonts. The frame editor also provides tools for image reproduction, and image manipulations, such as moving, deleting, scaling and rotating images or portions of images. Further image manipulations include screen capture and the use of a full color palette for frame creation and editing.

The "modifying physical frame parameters" option refers to manipulation of frame size. Frames can make reference to interactive video and speech materials. The author uses the tools provided through the "interactive video/speech" option to establish the links of frames to these materials.

The main menu also allows the author to remove frames from courses, copy frames from one course to another, and to run the training package.

FIG. 10(c) shows some of the types of frames available to a course author. These are meant to be illustrative rather than limiting. The title frame 901 is used to display the course title and listing the course objectives. Other possible entries on the title frame are company logos and names of course authors, as well as last version of course.

The introductory frames 903 are used to communicate, to the student, the mechanics of the course, e.g., how to execute the package, how to answer various types of questions which appear in the course, who to contact if any difficulties arise, and how to exit the course should the student desire to leave. Title frame 901 and the introductory frames 903 are both text frames, i.e., they are non-interactive.

Frames 905 through 913 are interactive question frames. These are both used to allow the student to navigate through the course and to ask the student questions about the subject matter of the course. The latter category, subject matter questions, as discussed above, are created by an expert system. The course author is not necessarily the subject matter expert. The course author interviews the subject matter expert and creates an expert interview file. The expert system accepts as its input the expert interview file and automatically creates templates for course frames. The author edits these frames using the frame editing facilities of the authoring system.

The authoring system allows the author to define a last frame 915 specification. The last frame 915 is a summary frame and provides the student with information such as which is next course in a sequence of courses, who to contact to obtain a course completion certificate, and a sign-off message. The last frame is also used to verify that the person who completed the course is the same person who started taking the course.

FIG. 11 shows three views of a course. In the first column is the authoring system interactions used to create the course, in the second column is the structure of the course, and in the third column is the student's view of the course. By being able to view multiple windows, the course author has access to both the authoring system interaction view and the student's view.

While FIG. 11 shows some example frames that may be used in a course, a course is not limited to this structure, and a person skilled in the art will realize many possible alternative course structures.

The authoring system displays screen 150 by selecting the "Title Frame" option in the menu shown in FIG. 10(c). The author enters the course title and course objectives in the indicated fields of screen 150. The authoring system takes this information and creates the structure 152 for the corresponding title frame. When the student executes the course, the title frame is displayed as shown in screen 154.

The author creates the introductory frames by first selecting the "Introductory Frames" option on the menu shown in FIG. 10(c). The introductory frames may either be entered interactively or incorporated from computer files, as shown in screen 156. The introductory frames may also be derived from the expert interview. When the author has completed creating the introductory frames they are incorporated into the course structure in blocks 158. The student views the introductory frames as shown in screen 160. The introductory frames provide means of navigation forward and backwards through the frames, as indicated by buttons 162A and 162B. The forward and backward navigation can also be accomplished by using cursor keys or specially designated function keys.



Certain types of frames create multiple paths through the course. This is illustrated by YES/NO question frames 164 through 172. The author is prompted by the authoring system for text of a question, e.g., "Do you wish to continue the lesson?". This creates the required structure in the course, such as the frame 166 and the logic block 172. The course displays the screen 168 to the student. Logic block 172 provides two paths: one for the "yes" answer and one for the "no" answer.

In the course shown in FIG. 11 the "no" response results in the display of a text frame 178. The author is prompted for the text or a filename of a file where the text can be found, as shown in block 174.

Another multiple path frame is the menu frame 182 shown in FIG. 11(b). It is created using screen 180 of the authoring system. In screen 180 the author is prompted for the number of choices in the menu and the titles of the various choices. The authoring system uses this information to create the structure shown below block 182. The menu created by the authoring system is displayed to the user as shown in screen 184. Screen 184 also displays to the user the topics that he or she has completed as indicated by the V symbol displayed next to the course title. The author is also prompted for frame identifiers for the frames that represent the paths corresponding to the various choices (This is not shown). Each path corresponding to a menu choice consists of a sequence of frames 186A-186F, respectively. The paths exiting a sequence of frames 186 may take one of several routes, e.g., back to menu frame 182 for further selections, as shown from frames 186A-186E, or to other parts of the course, as shown exiting from frame 186F.

Screen 188 shows an example of the interaction between the authoring system and the course author for the creation of a text frame which make up one of the sequences selected through menu frame 182, in this case a multiple choice frame. The frame may have originated as a template created by the expert system from the expert interview and subsequently edited by the author. An example of the flow of control from a multiple choice frame is shown in FIG. 11(d) as blocks 264 through 272, and is discussed in further detail below.

Another possible interaction frame is the "true/false" question frame, shown in FIG. 11(c) as blocks 250-262. The authoring system requires the author to create a question, indicate whether "False" or "True" is the correct response, and provide feedback information for both alternatives. From this information the authoring system creates the structure shown as frame 252, logic block 256 and feedback frames 258 and 260. The student views the question as shown in screen 254, which also includes response buttons 255A and 255B. When the student buttons a response, e.g., the F button 255B, control in the course goes through the path corresponding to that button, which in the shown example is through feedback frame 260. Feedback frame 260 is displayed as shown in screen 262.

FIG. 11(d) shows the course structure corresponding to some additional interaction screens. (Not shown is the authoring system interaction and the student interaction. These are similar in nature to those of the frames discussed above.) Multiple choice question frame 264 can have two or more possible answers. Usually one answer represents a correct response. A text frame 266-272 is associated with each response to give the student feedback regarding the entered response. For incorrect responses the course may return to the question frame 264, as shown, or, alternatively, not give the student the opportunity to attempt to answer the question again.

Blocks 274-280 represent a question asked through a fill-in-the-blank frame. Text frame 274 introduces the question and gives the student any additional information needed to answer the question. Question frame 276 presents the question to the student with blanks to fill in. Block 277 is a pattern matcher, which functions to determine whether the answer provided by the student matches the pattern given by the author. As with the multiple choice question and the true/false question, discussed above, the course provides feedback to the student depending on the student's response to the question, as shown by blocks 278 and 280.

The example course shown in FIG. 11, concludes with frame 290 which provides the course wrap-up information discussed above in conjunction with FIG. 10(c).

While this invention has been described with reference to illustrative embodiments, this description is not intended to be construed in a limiting sense. Various modifications and combinations of the illustrative embodiments, as well as other embodiments of the invention, will be apparent to persons skilled in the art upon reference to the description. It is therefore intended that the appended claims encompass any such modifications or embodiments.

We claim:

1. A network system for computer aided instruction, comprising:

- a main computer including a repository for storing courseware;
- a network of servers connected to said main computer, each of said servers having a control module;
- a plurality of local area networks, each of said local area networks connected to a server, and each of said local area networks comprising a plurality of interconnected workstations;
- a distributed delivery system responsive to a request of said server for a course of said courseware, selectively operable to search said network of said servers for said server where said course resides, operable to transfer said course from said server where said course resides, and selectively operable to retrieve said course from said repository if said course cannot be found at said server;

an authoring system distributed over a workstation of said workstations, said servers and said main computer, and operable to transfer courses of said courseware from said workstation to said repository; and

- a course management system distributed over said workstation, said servers and said main computer, and operable to manage course enrollment and to monitor student performance at said servers, and further operable to transfer information corresponding to said course enrollment from said servers to said main computer;

wherein said network of servers comprises a first set including said servers connected to said main computer, a second set including said servers connected to other servers and to said main computer, and a third set including said servers connected to said other servers; and

wherein said course is prevented from being copied by said control module.

2. The network system of claim 1, wherein said repository comprises:

- a database for storing additional information corresponding to said courses and students enrolled in said courses; and
- file storage for the storage of programs implementing said courses.

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3. The network system of claim 1, wherein said distributed delivery system comprises programs distributed over said servers in said workstation; and

wherein said programs communicate by sending messages.

4. The network system of claim 1, wherein said main computer further includes a supervisory module.

5. The network system of claim 4, wherein said supervisory module is operable to automatically archive information, to manage student enrollment, and course accounting.

6. The network system of claim 5, wherein said supervisory module is operable to request said other servers in said network to provide said supervisory module with information required by said supervisory module to maintain said repository.

7. The network system of claim 6, wherein said supervisory module communicates with said other servers by sending messages across said network.

8. The network system of claim 7, wherein said messages are standardized so that said servers of different manufactures can communicate with said other servers.

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9. A computer aided instruction system, comprising:

a network of interconnected servers;

a main computer connected to at least one of said servers;

a repository connected to said main computer;

at least one workstation connected to one of said servers; and

an authoring system distributed over said at least one workstation, said servers, and said main computer to deliver a course from said at least one workstation to said repository; and

a diagnostic expert system to increase or decrease the level of detail of said course.

10. The computer aided instruction system of claim 9, wherein said authoring system comprises programs resident on said at least one workstation, said servers, and said main computer.

11. The computer aided instruction system of claim 10, wherein said programs communicate by sending messages.

\* \* \* \* \*





US005960403A

# United States Patent [19]

## Brown

[11] Patent Number: 5,960,403

[45] Date of Patent: Sep. 28, 1999

[54] **HEALTH MANAGEMENT PROCESS CONTROL SYSTEM**

[75] Inventor: Stephen J. Brown, San Mateo, Calif.

[73] Assignee: Health Hero Network, Mountain View, Calif.

[21] Appl. No.: 09/136,512

[22] Filed: Aug. 19, 1998

**Related U.S. Application Data**

[63] Continuation-in-part of application No. 08/481,925, Jun. 7, 1995, abandoned, which is a continuation-in-part of application No. 07/977,323, Nov. 17, 1992, Pat. No. 5,307,263, and a continuation-in-part of application No. 08/666,242, Jun. 20, 1996, abandoned.

[51] Int. Cl.<sup>6</sup> ..... G06F 17/40

[52] U.S. Cl. .... 705/2; 345/336; 395/200.38

[58] Field of Search ..... 705/2, 3; 345/326, 345/336, 337, 338; 395/200.38, 200.39, 200.41; 600/300

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Primary Examiner—Stephen R. Tkacs

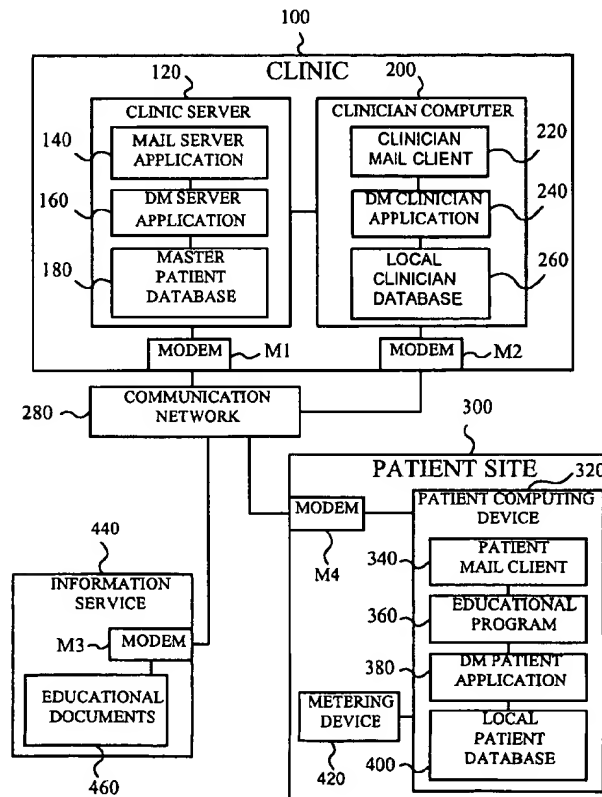
Attorney, Agent, or Firm—Lumen Intellectual Property Services

[57]

**ABSTRACT**

A system and method for remotely monitoring a patient and for training the patient to comply with a treatment plan for a health condition. A patient computing device collects data relating to the patient's health condition and transmits the data to a clinician computer via a communication network. The data is analyzed in the clinician computer to determine an educational need of the patient for treating the health condition. An educational program corresponding to the patient's educational need is selected and a pointer to the educational program is embedded in an electronic message to the patient. The educational program is started on the patient computing device by selecting the embedded pointer in the electronic message. As the patient works with the educational program, new data relating to the patient's health condition is collected in the patient computing device and transmitted to the clinician computer for analysis. With this continuous feedback loop between the patient and clinician, the clinician is able to monitor the patient's progress and effectively train the patient to comply with the treatment plan.

29 Claims, 15 Drawing Sheets



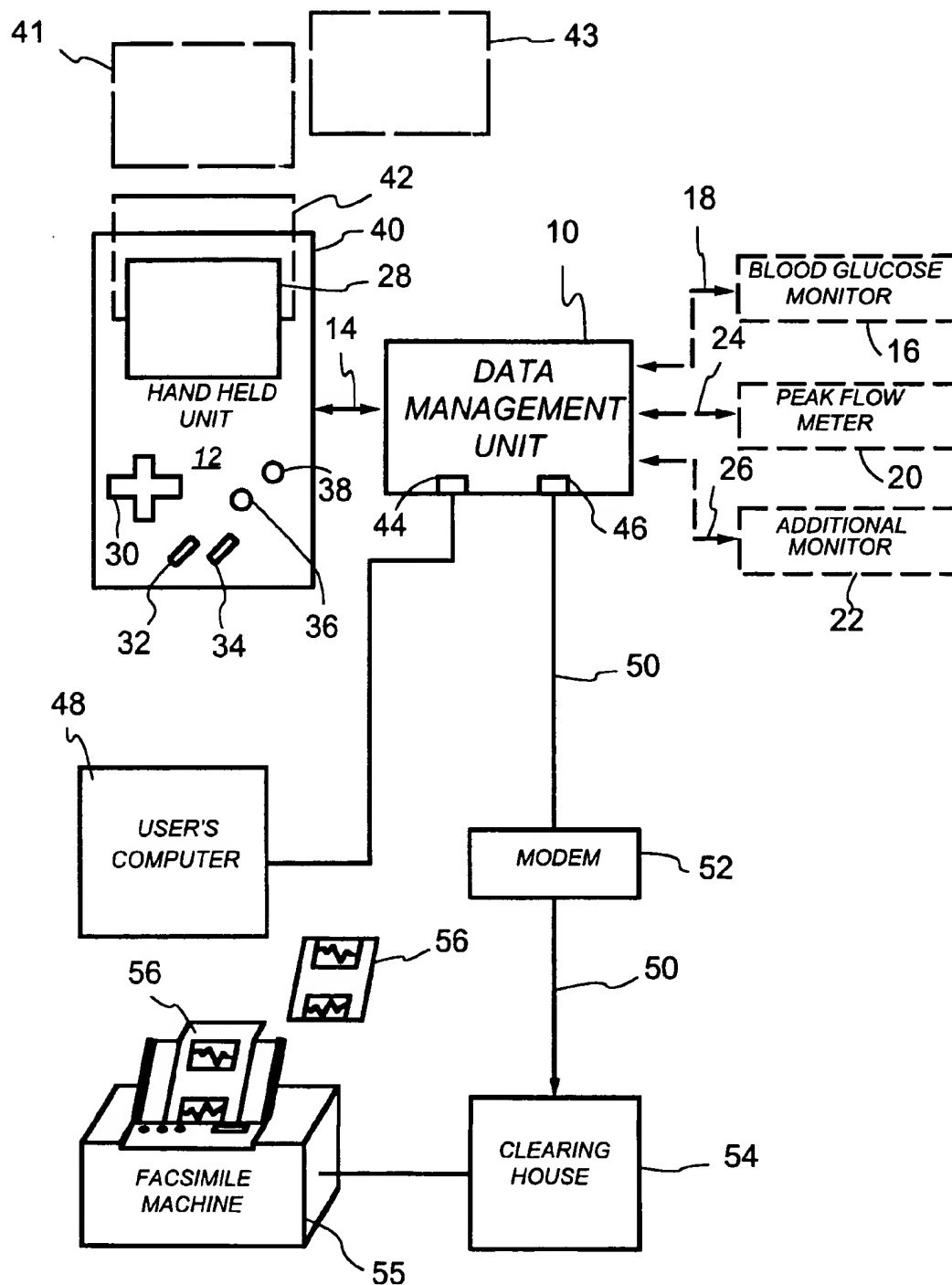
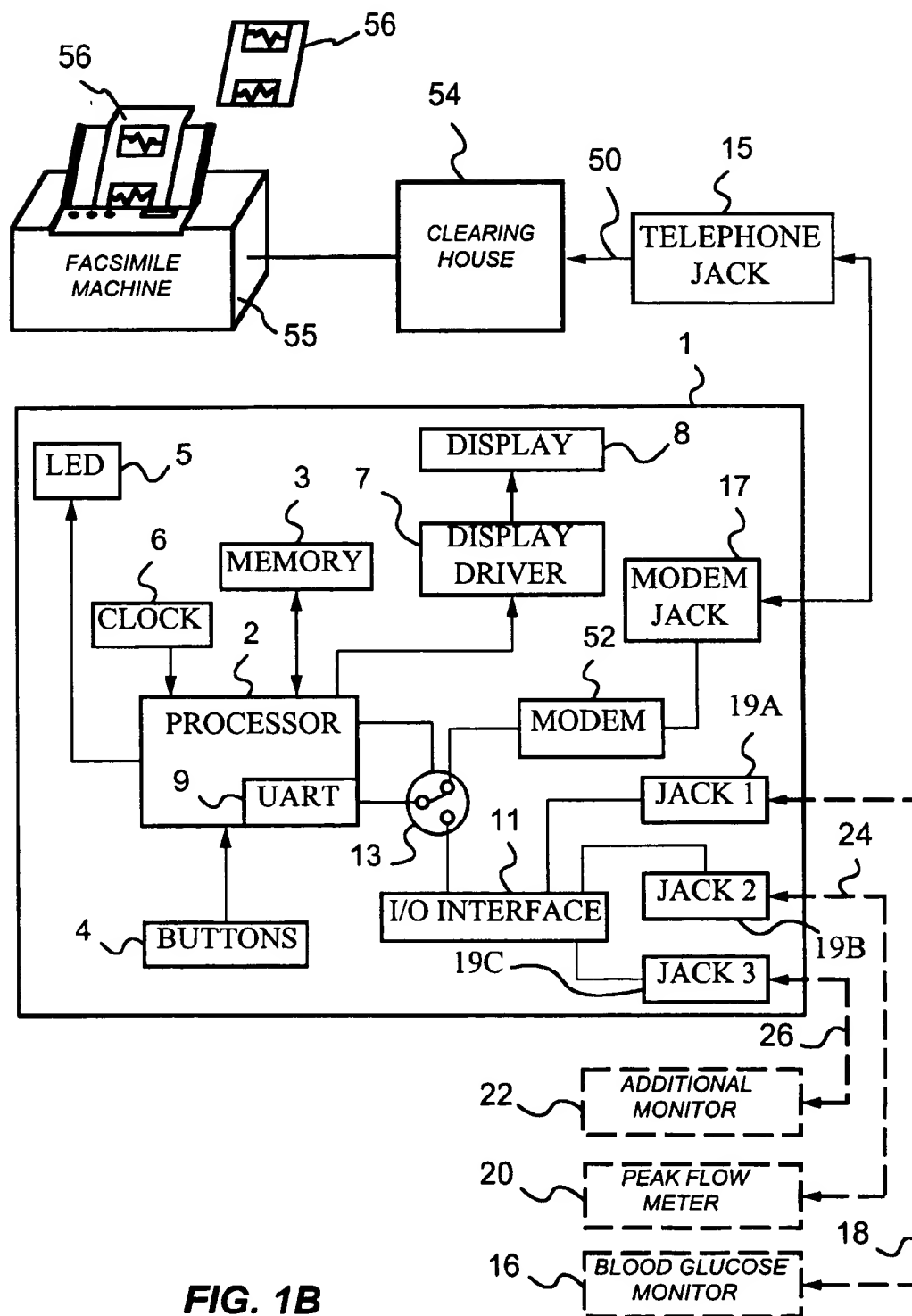


FIG. 1A

**FIG. 1B**

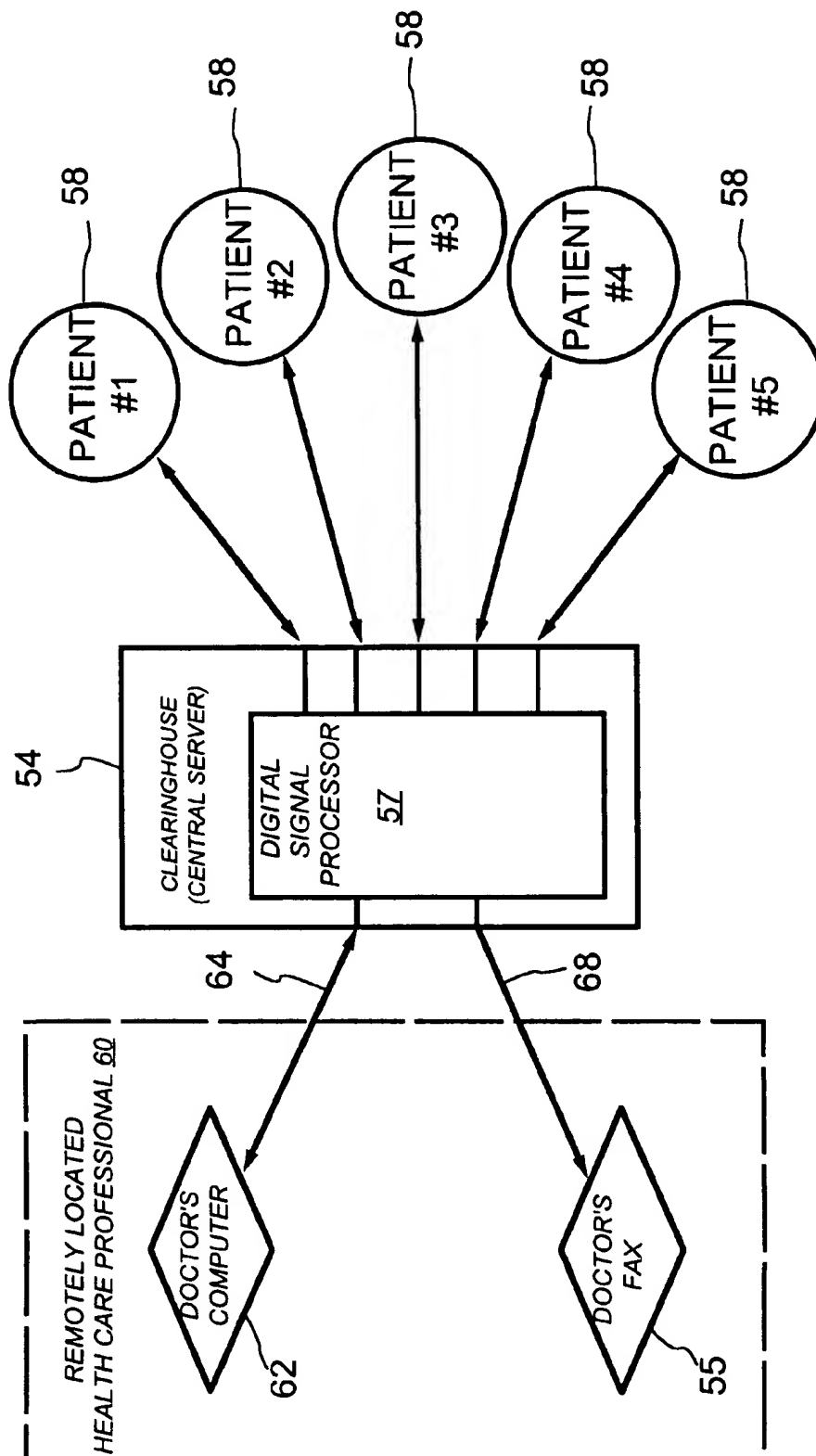


FIG. 2

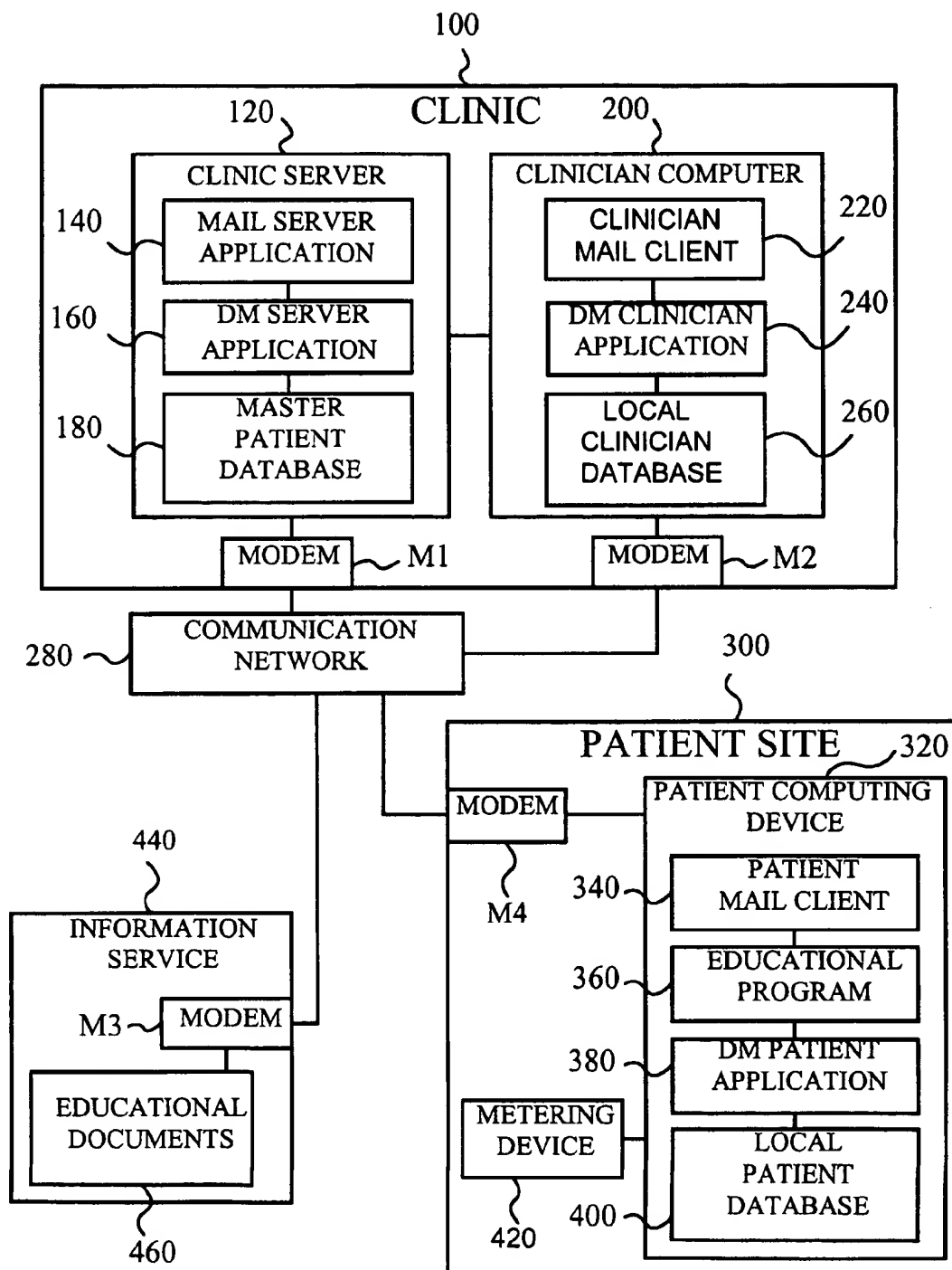
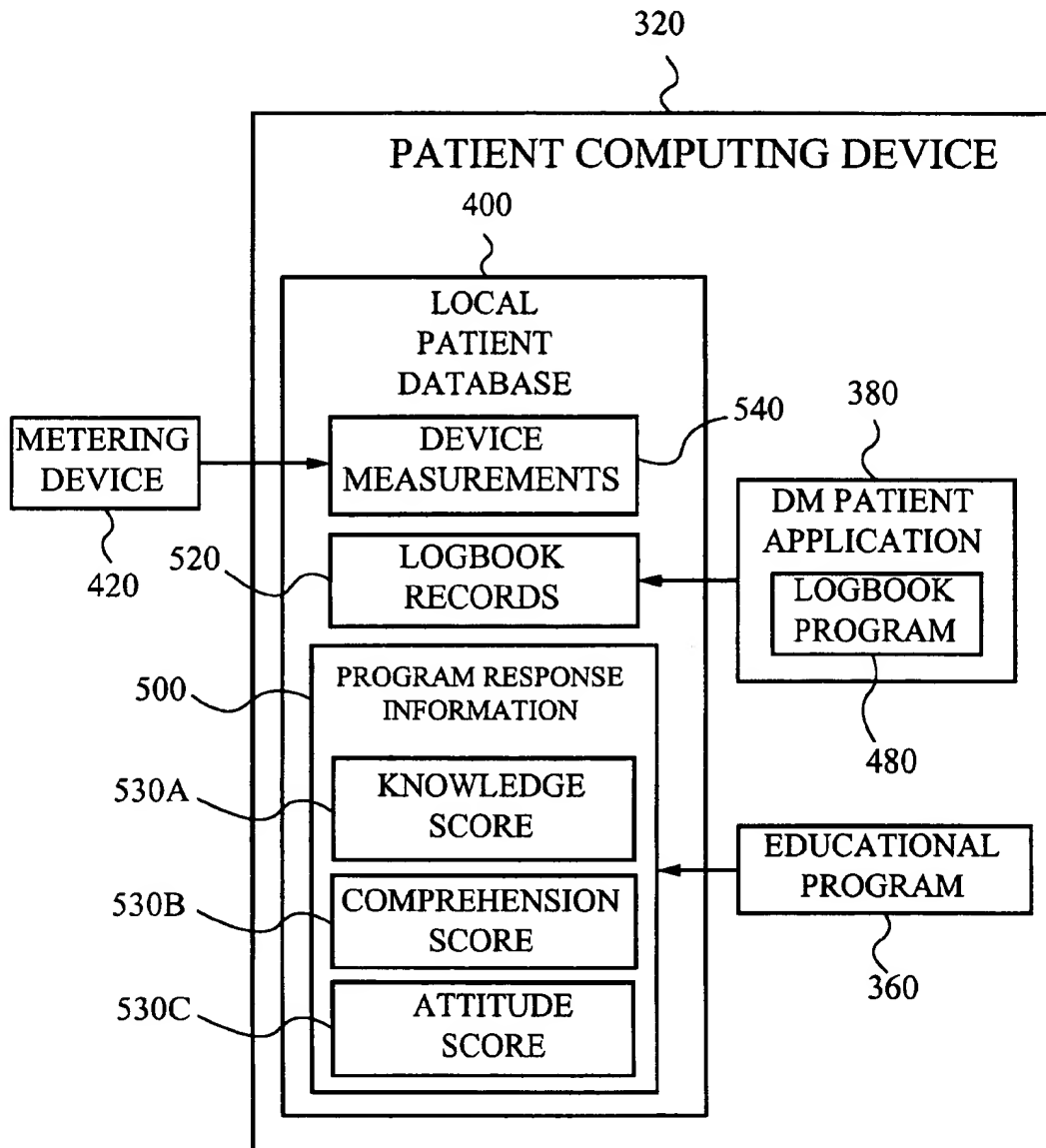


FIG. 3

**FIG. 4**

560

# ADD/EDIT LOGBOOK ENTRY

SELECT BLOOD GLUCOSE READING

DATE: MARCH 30, 1996 TIME: PRE BREAKFAST READING 120 MG/DL

580 600 620 740 760

OK CANCEL

NOTES

PLANNING A TRIP TO EUROPE THIS SUMMER

710

SELECT EVENT

640 A B C D

1 FASTING 2 PRE EXERCISE 3 AFTER EXERCISE 4 ILLNESS 5 HYPOGLYCEMIA

680 660

MEDICATION

INSULIN TYPE R 20 UNITS

700

ADD MEDICATION

720

FIG. 5

780

ADD/EDIT LOGBOOK ENTRY

SELECT DAY

DATE: MARCH 30, 1996

OK

CANCEL

☒ A  
☐ B  
☐ C  
☐ D

SELECT EVENT

1 MILD WHEEZING  
2 SEVERE WHEEZING  
3 MILD COUGHING  
4 SEVERE COUGHING  
5 CHEST TIGHTNESS

ADD >>

<< REMOVE

A2 SEVERE WHEEZING

ADD >>

<< REMOVE

MEDICATION

ALBUTEROL 2 PUFFS

ADD MEDICATION

NOTES

PLANNING A TRIP TO EUROPE THIS SUMMER

FIG. 6



800

**ADD MEDICATION**

**MEDICATION**

820 INSULIN TYPE R 810

INSULIN TYPE NL

INSULIN TYPE NPH

☐ Q<sub>OTHER</sub>:

**DOSAGE:** 20 UNITS 840

OK 860

CANCEL 880

**FIG. 7**

900

**ADD MEDICATION**

**MEDICATION**

ALBUTEROL

CROMOLYN

NODOCROMIL

ASMACORT

☐ Q<sub>OTHER</sub>:

**DOSAGE:** 2 PUFFS

OK

CANCEL

**FIG. 8**

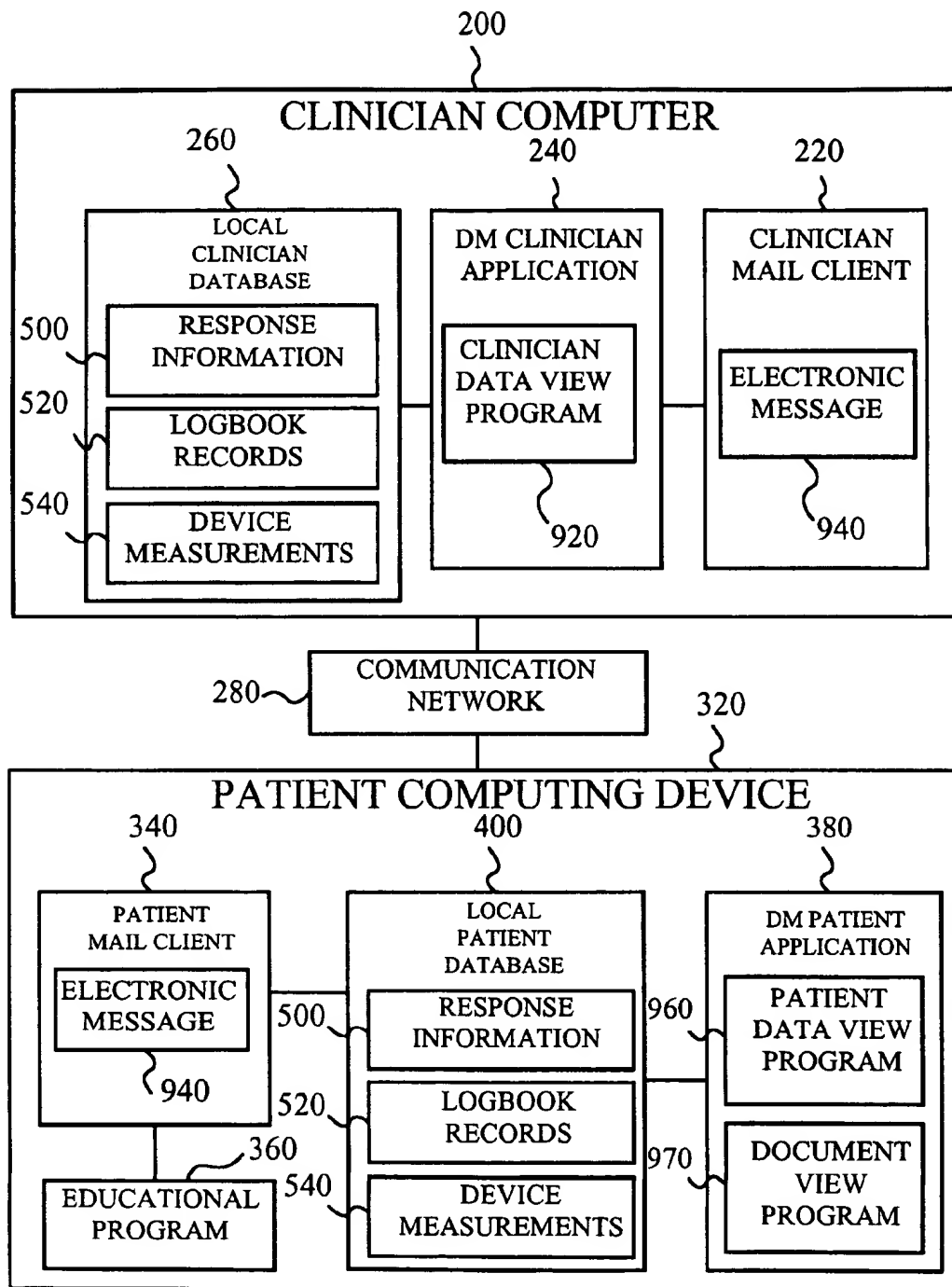


FIG. 9

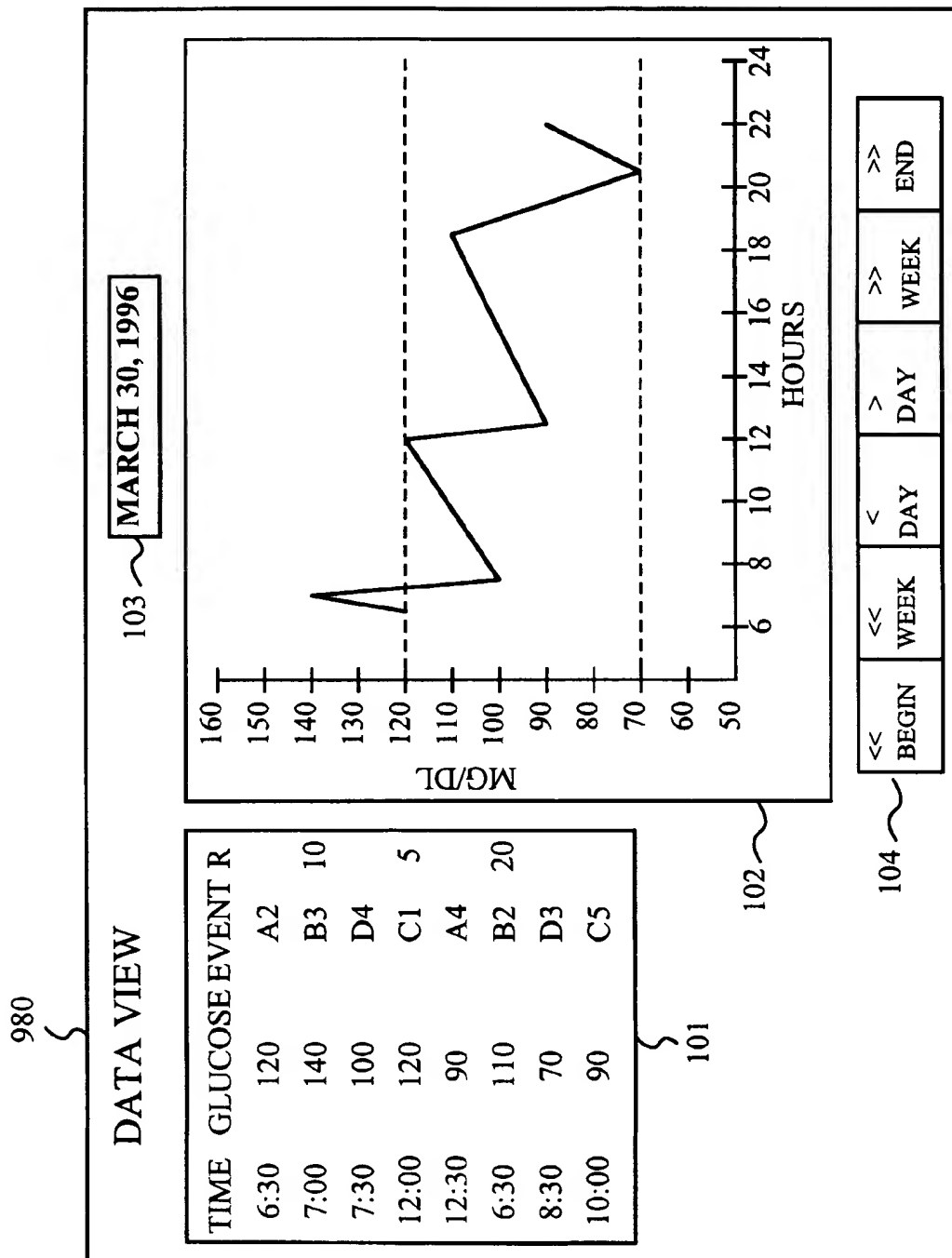
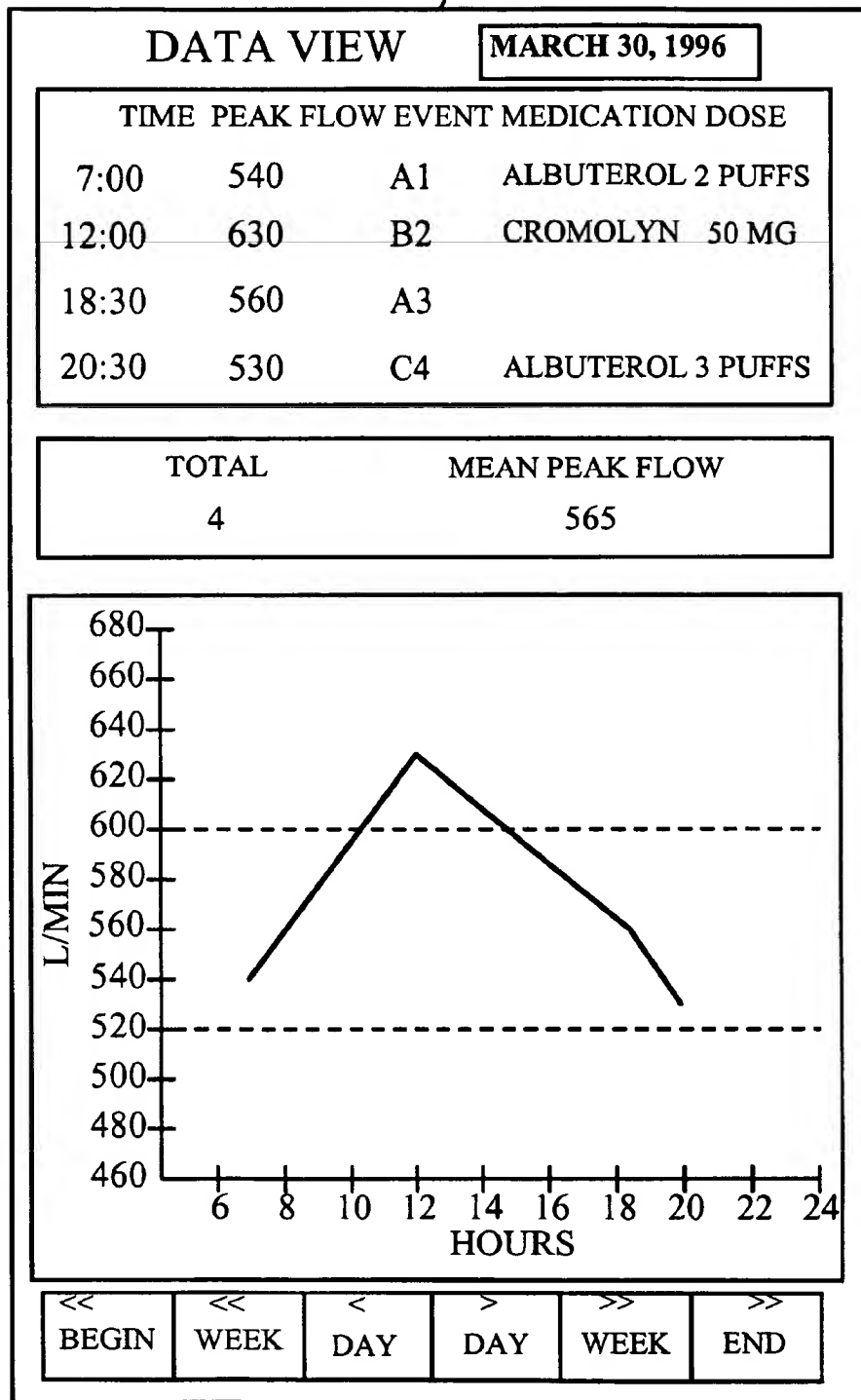
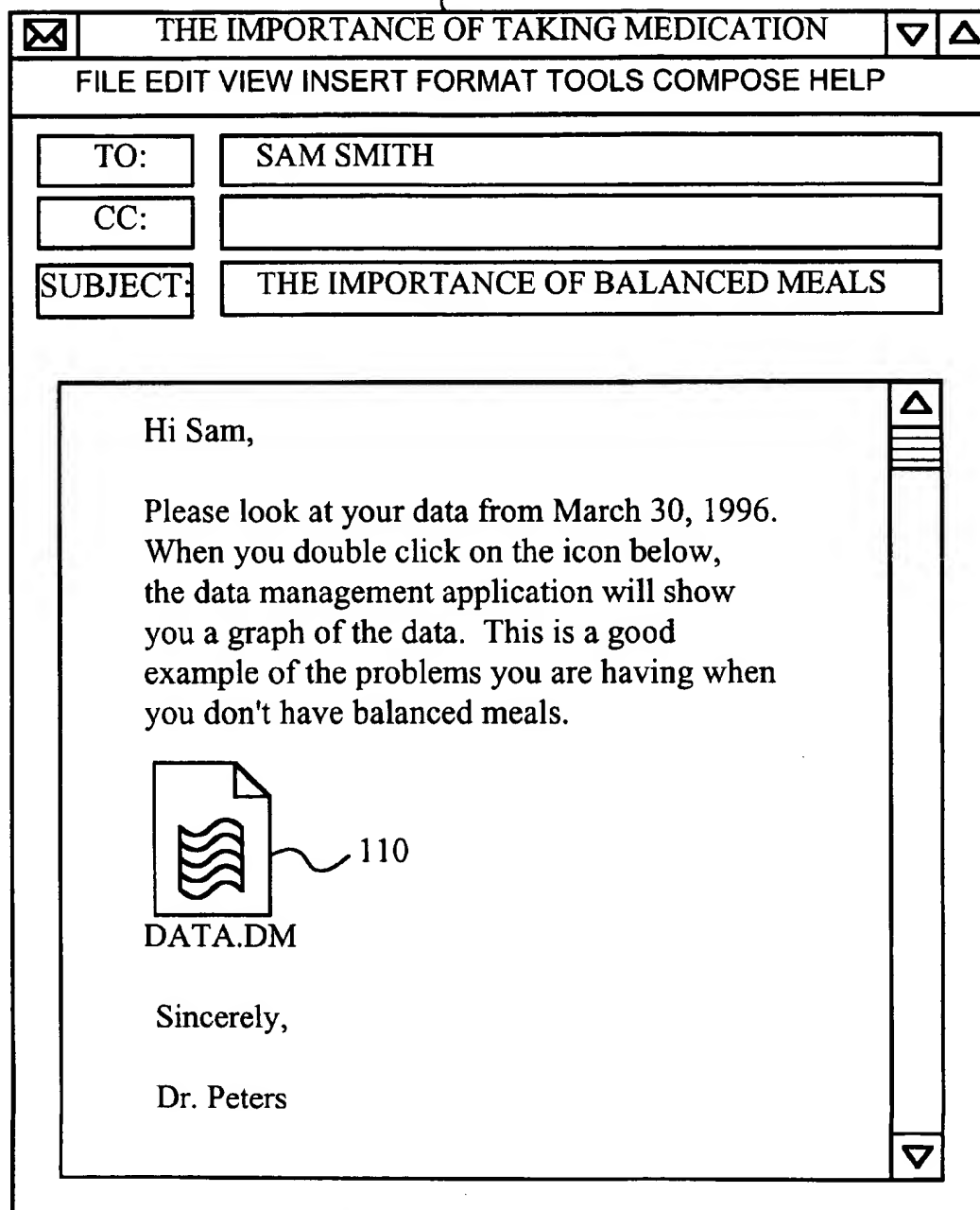


FIG. 10

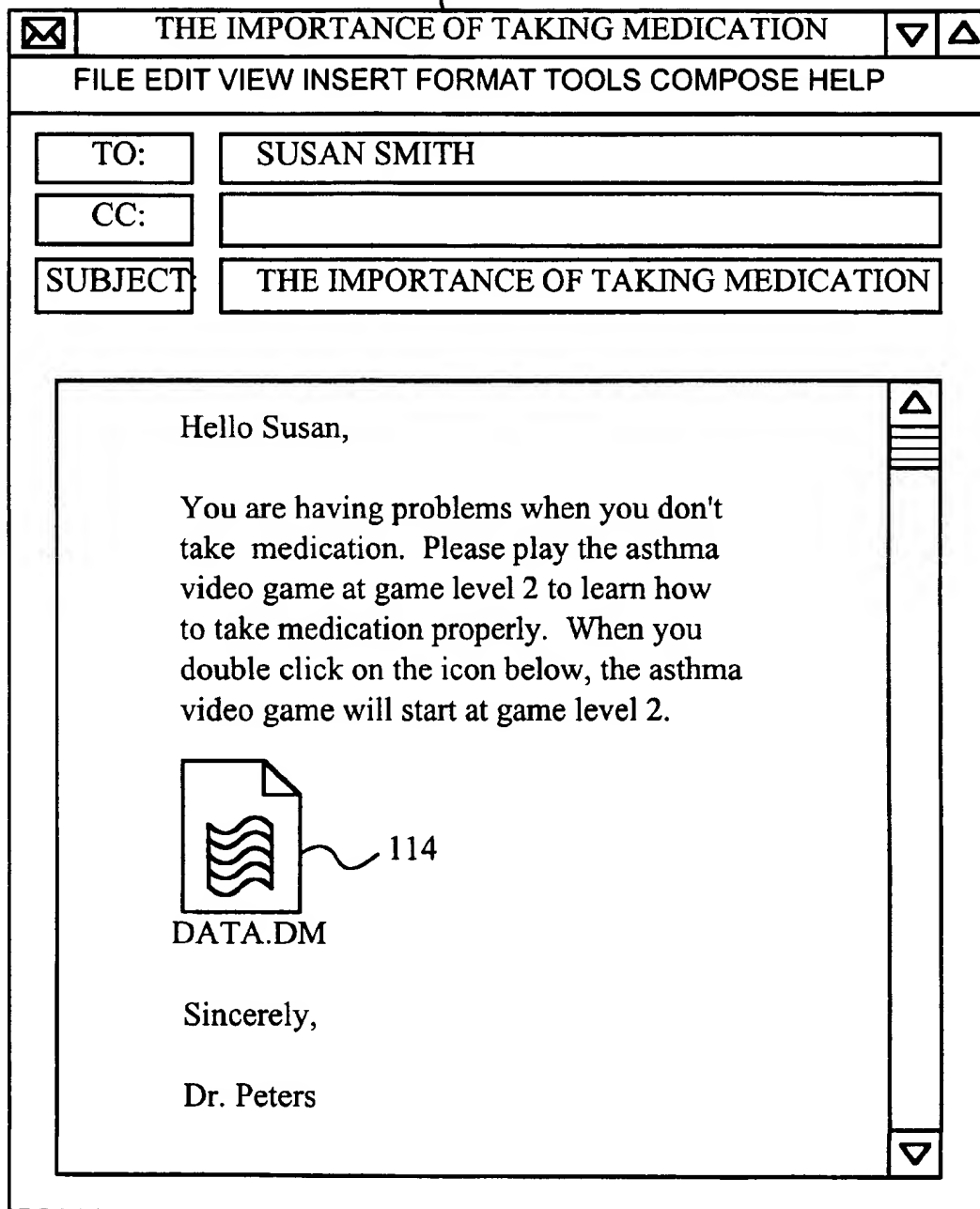
106

**FIG. 11**

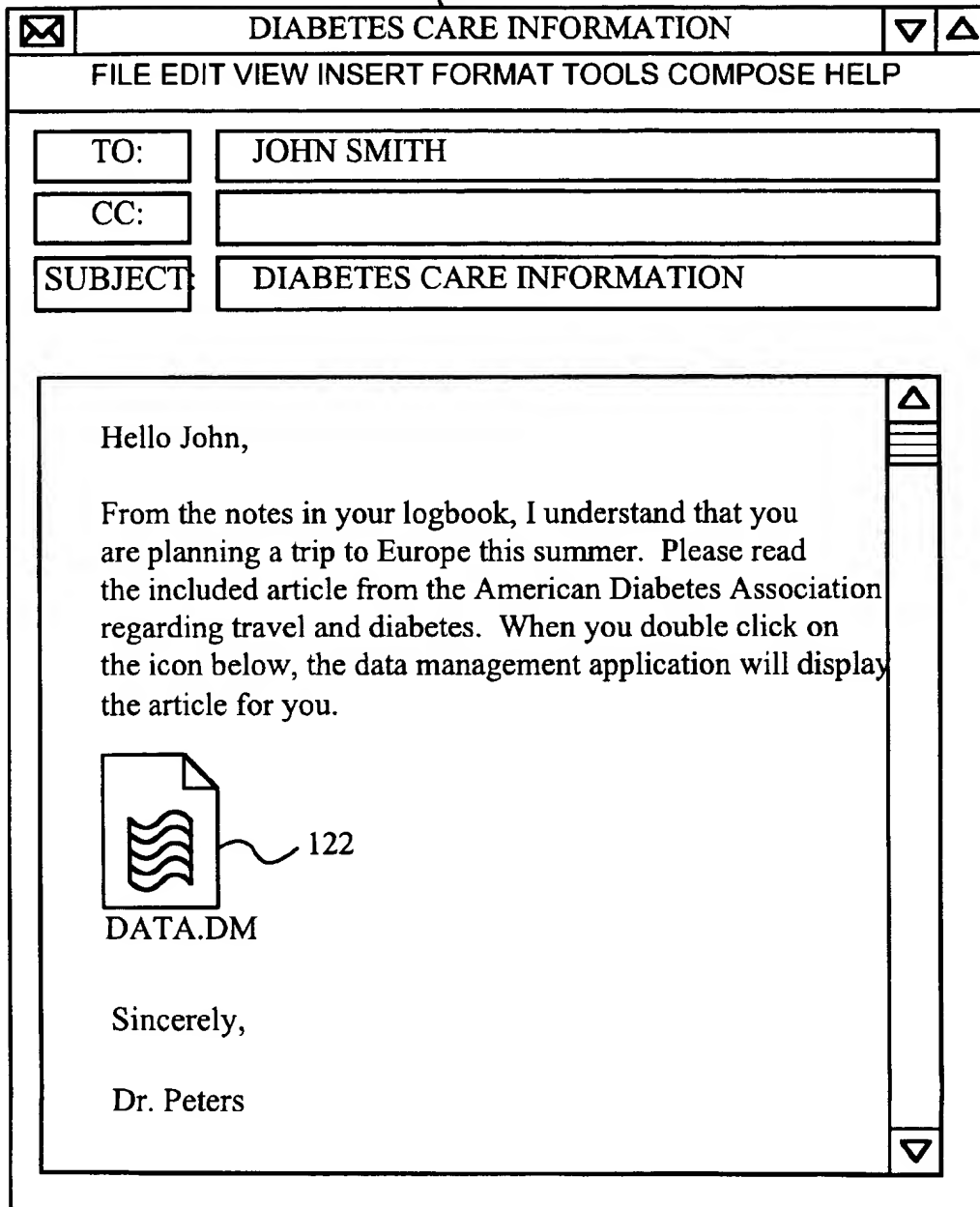
940

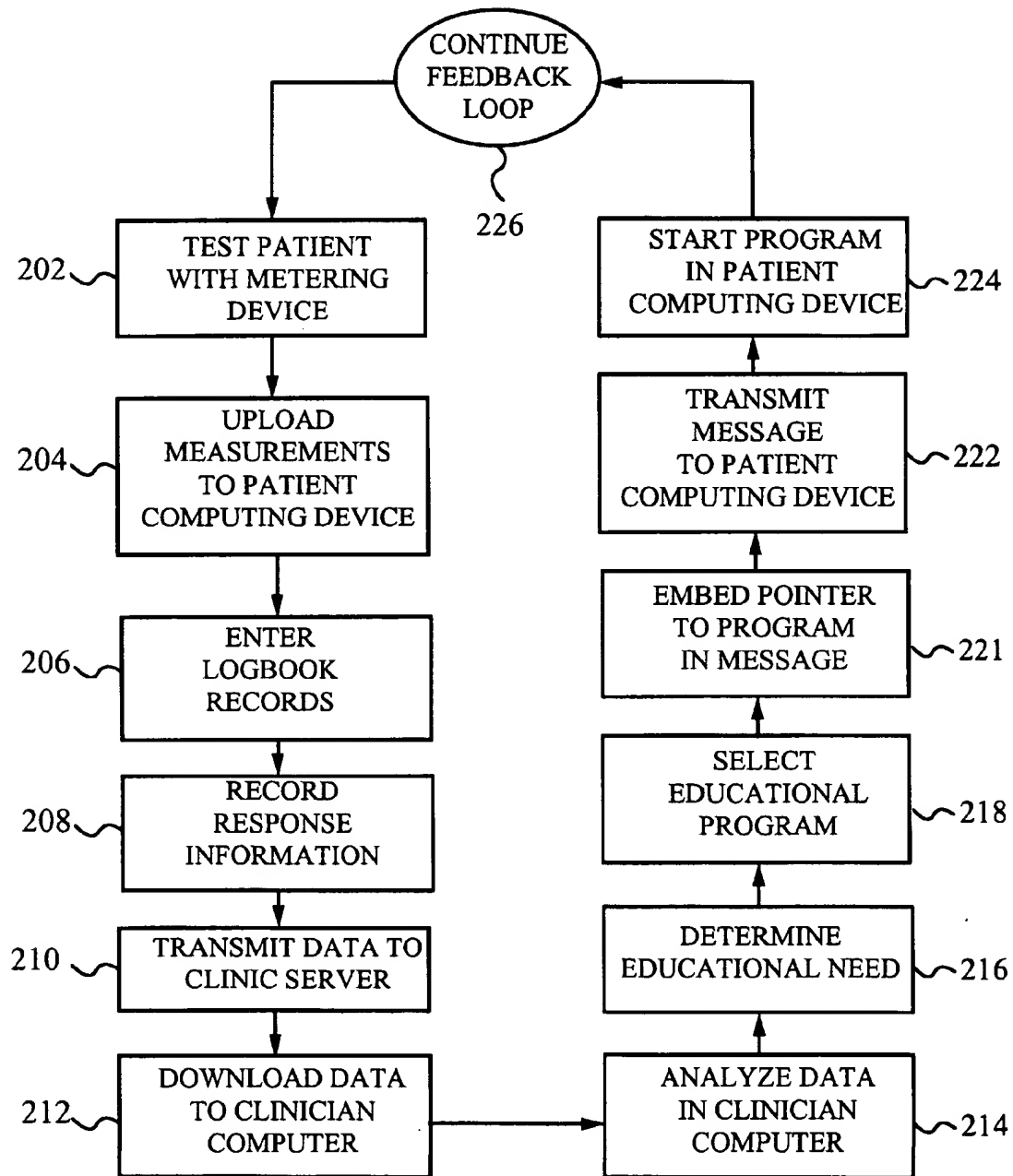
**FIG. 12**

112

**FIG. 13**

121

**FIG. 14**

**FIG. 15**



## HEALTH MANAGEMENT PROCESS CONTROL SYSTEM

### RELATED APPLICATIONS

This is a continuation-in-part of application Ser. No. 08/481,925, filed Jun. 7, 1995, now abandoned which is a continuation-in-part of application Ser. No. 07/977,323, filed Nov. 17, 1992, and issued as U.S. Pat. No. 5,307,263. This application is also a continuation-in-part of application Ser. No. 08/666,242, filed Jun. 20, 1996, now abandoned.

### BACKGROUND

#### 1. Field of the Invention

The present invention relates to the field of health management, and in particular to a system and method for remotely monitoring a patient and for training the patient to comply with a treatment plan for a health condition.

#### 2. Description of the Prior Art

In recent years, an increasing number of healthcare providers have initiated outpatient or home healthcare programs for their patients. The potential benefits of these home healthcare programs are particularly good for chronically ill patients, such as those suffering from asthma or diabetes, who must treat their diseases on a daily basis. However, the success of these home healthcare programs is currently limited by the ability of healthcare providers to assess, monitor and train patients to comply with treatment plans for their health conditions.

Many systems have been developed for remotely monitoring a patient's compliance with a prescribed medication plan. For example, U.S. Pat. No. 5,390,238 issued to Kirk et al. on Feb. 14, 1995 discloses a home healthcare and communication support system. The system includes a health support unit located in the patient's home for monitoring and supporting a patient. The health support unit is networked to a remote monitoring terminal for continuous remote monitoring of the patient. The health support unit includes a medication controller for measuring the patient's medicine compliance and a communications module for communicating with an operator at the monitoring terminal. The health support is further networked to the patient's healthcare provider to allow the healthcare provider access to the patient's medicine compliance data.

A similar system for monitoring a patient's medicine compliance is described in U.S. Pat. No. 5,016,172 issued to Dessertine on May 14, 1991. The system includes an automatic medicine compliance monitoring device for measuring the patient's actual medicine consumption. The monitoring device is connected to a patient computing device for recording the patient's medicine consumption. The patient computing device is further connected to a remote monitoring terminal for displaying the patient's medicine compliance to a healthcare provider. The system optionally includes a second monitoring device for monitoring a physical condition of the patient, such as heart rate, blood pressure, blood glucose, or respiration.

Although the systems described by Kirk and Dessertine allow remote monitoring of a patient's health condition and medicine compliance, they have no mechanism for ensuring patient compliance with a treatment plan. Further, these systems are not directed at providing the patient guidelines for treating a health condition. They are simply designed to monitor the patient from a remote location.

Numerous systems have also been developed for prompting a patient take prescribed doses of medication in addition

to remotely monitoring the patient's health condition. For example, U.S. Pat. No. 5,501,231 issued to Kaish on Mar. 26, 1996 describes a patient-operated, hand-held system for testing and recording peak flow rates of an asthma patient.

The system includes a peak flow meter for measuring the patient's peak flow rates and an alarm for prompting the patient to take a prescribed dose of medication. In using the system, the patient records his or her peak flow rates over a predetermined period of time, typically fifteen days to six months, before returning the system to a doctor for recovery of the peak flow data. At this time, the doctor may optionally reprogram the system with new alarm times and prescribed medicine doses.

Although the system described by Kaish has the advantage of prompting a patient to take medication, it lacks any mechanism for training the patient to actually comply with the prompts. The system is limited to issuing preprogrammed medicine instructions to the patient without teaching the patient why or how to follow the instructions. Further, the system cannot identify any problems the patient is experiencing in following a treatment plan for his or her health condition or teach the patient how to solve the problems. As a result, the patient may not be able to comply with the prescribed treatment plan, severely limiting the effectiveness of this home healthcare system. Additionally, the system described by Kaish does not permit continuous feedback between the doctor and patient for ongoing adjustment of the treatment plan.

Another system for remotely monitoring a patient and for prompting a patient to take a prescribed dose of medication is disclosed in U.S. Pat. No. 4,731,726 issued to Allen on Mar. 15, 1988. Allen describes a diabetes management system having a blood glucose meter for measuring a patient's blood glucose levels and for sending the blood glucose measurements to a physician. The system further includes a user interface for entering in the system data relating to the patient's medication usage, exercise routine, and dietary intake. Based on the entered data, the system calculates a recommended insulin dose for the patient using a physician prescribed algorithm stored in its memory.

Allen's system suffers from the same disadvantage as Kaish's system in failing to train the patient to comply with the prescribed treatment plan. The system is limited to issuing dosage instructions based on a preprogrammed algorithm without identifying any problems the patient is experiencing with the diabetes program or teaching the patient how to solve the problems. Consequently, the effectiveness of this diabetes management system is also limited.

A similar system for home management of diabetes is disclosed in U.S. Pat. No. 5,109,974 issued to Beckers on May 28, 1991. The system includes a physician computer for developing a diabetes therapy program and a patient recorder having an interface for exchanging data with the physician computer. The recorder has a blood glucose test strip for measuring the patient's blood glucose levels and a user interface for entering in the recorder data relating to the patient's insulin usage, exercise routines, and dietary intake. Using the patient data and therapy guidelines downloaded from the physician computer, the recorder calculates and displays to the patient a recommended insulin dosage, exercise plan, and diet. The recorder also receives from the physician computer new therapy guidelines developed from the patient's recorded data.

Although the diabetes management program disclosed by Beckers has the advantage of adjusting a patient's recommended therapy program based on remote monitoring of the

patient, it also has the same disadvantage as the previous systems in failing to teach the patient how to follow the prescribed treatment plan. Becker's system has no mechanism for identifying problems the patient is experiencing with the diabetes program or for teaching the patient how to solve the problems. As a result, Becker's system is also ineffective for training the patient to comply with the diabetes treatment plan.

### OBJECTS AND ADVANTAGES OF THE INVENTION

In view of the above, it is an object of the present invention to provide a system and method for remotely monitoring a patient and for effectively training the patient to comply with a treatment plan for a health condition. It is another object of the invention to provide a method for teaching a patient to solve a specific problem the patient is experiencing with a treatment plan. A further object of the invention is to provide a system that allows continuous feedback between a clinician and patient for ongoing adjustment of a treatment plan.

The invention provides a new and useful system for healthcare monitoring and patient training based on a small microprocessor-based unit or a personal computer which is networked with the clinician's resources and requisite databases.

These and other objects and advantages will become more apparent after consideration of the ensuing description and the accompanying drawings.

### SUMMARY OF THE INVENTION

The invention presents a system and method for remotely monitoring a patient and for training the patient to comply with a treatment plan for a health condition. The system includes a patient computing device, such as a personal computer or network terminal, for collecting data relating to the health condition. In the preferred embodiment, the data includes measurements of a physical characteristic of the health condition, such as blood glucose measurements for a diabetic patient or peak flow measurements for an asthmatic patient. Also in the preferred embodiment, the data includes measurements of a psychological characteristic of the health condition, such as the patient's knowledge, comprehension, or attitude in treating the health condition.

The system further includes a clinician computer having a data analysis program for analyzing the data to determine an educational need of the patient. The clinician computer also has a message program, such as an electronic mail program, for composing an electronic message to the patient. The electronic message contains a pointer to an educational program corresponding to the patient's educational need. The pointer is a prompt embedded in the message. When the patient selects the pointer the latter loads and executes the educational program instructions linked to the message. A communication network connects the patient computing device and the clinician computer and transmits the data and the electronic message therebetween.

A preferred method of using the system includes the steps of entering data relating to the patient's health condition into the patient computing device and transmitting the data from the patient computing device to the clinician computer via the communication network. The method further includes the steps of analyzing the data received in the clinician computer to determine an educational need of the patient and selecting an educational program corresponding to the educational need. A pointer to the selected educational

program is then embedded in an electronic message to the patient. The electronic message is transmitted through the communication network from the clinician computer to the patient computing device.

The educational program is started on the patient computing device when the patient selects the embedded pointer in the electronic message. As the patient works with the educational program, new data relating to the patient's health condition is collected in the patient computing device and transmitted to the clinician computer for analysis. With this continuous feedback loop between the patient and clinician, the clinician is able to monitor the patient's progress and effectively train the patient to comply with the treatment plan.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a block diagram that illustrates a healthcare monitoring system arranged in accordance with the invention.

FIG. 1B is a schematic block diagram illustrating an alternative healthcare monitoring system arranged in accordance with the invention.

FIG. 2 diagrammatically illustrates monitoring systems constructed in accordance with the invention connected in signal communication with a remotely located computing facility which includes provision for making the data supplied by the monitoring system of the invention available to a designated healthcare professional and/or for providing data and instructions to the system user.

FIG. 3 is a schematic block diagram of the main components of a health management process control system according to the invention.

FIG. 4 is a schematic block diagram illustrating the entering of patient data into a patient computing device according to the method of the invention.

FIGS. 5-6 are sample logbook entry screens appearing on the patient computing device of FIG. 4.

FIGS. 7-8 are sample medication entry screens appearing on the patient computing device of FIG. 4.

FIG. 9 is a schematic block diagram illustrating the transmitting of an electronic message in response to an analysis of the patient data of FIG. 4 according to the method of the invention.

FIGS. 10-11 are sample data views appearing on the screen of a clinician computer and on the screen of the patient computing device of FIG. 4.

FIGS. 12-14 are sample electronic messages sent from a doctor to a patient according to the method of the invention.

FIG. 15 is a flow chart illustrating steps included in the method of the invention.

### DESCRIPTION

FIG. 1A depicts a self-care health monitoring system arranged in accordance with the invention. In the arrangement shown in FIG. 1A, a data management unit 10 is electrically interconnected with a computing device such as a computer or a handheld microprocessor-based unit 12 via a cable 14. In the depicted arrangement, data management unit 10 also is electrically interconnected with a blood glucose monitor 16 of the type capable of sensing blood glucose level and producing an electrical signal representative thereof.

Although FIG. 1A illustrates blood glucose monitor 16 as being connected to data management unit 10 by a cable 18,

it may be preferable to construct blood glucose monitor 16 as a plug-in unit that is placed in a recess or other suitable opening or slot in data management unit 10.

Also shown in FIG. 1A are two additional monitoring devices 20 and 22, which are electrically connected for serial data communication with data management unit 10 via cables 24 and 26, respectively. Monitoring units 20 and 22 of FIG. 1A represent devices other than blood glucose monitor 16 that can be used to configure the invention for self-care health monitoring applications other than (or in addition to) diabetes care. For example, as is indicated in FIG. 1A, the monitoring device 20 can be a peak-flow meter that provides a digital signal representative of the airflow that results when a person suffering from asthma or another chronic respiratory affliction expels a breath of air through the meter. As is indicated by monitor 22 various other devices can be provided for monitoring conditions such as blood pressure, pulse, and body temperature to thereby realize systems for self-care monitoring and control of conditions such as hypertension, certain heart conditions and various other afflictions and physical conditions. Upon understanding the hereinafter discussed aspects and features of the invention it will be recognized that the invention is easily implemented for these and other types of healthcare monitoring.

As is shown in FIG. 1A, handheld microprocessor unit 12 includes a display screen 28 and a plurality of switches or keys (30, 32, 34, 36, and 38), which are mounted on a housing 40. Located in the interior of housing 40, but not shown in FIG. 1A, are a microprocessor, memory circuits, and circuitry that interfaces switches 30, 32, 34, 36 and 38 with the microprocessor.

Stored in the memory of program microprocessor unit 12 is a set of program instructions that establishes a data protocol that allows microprocessor unit 12 to perform digital data signal processing and generate desired data or graphics for display on display unit 28 when a program cartridge 42 is inserted in a slot or other receptacle in housing 40. That is, program cartridge 42 includes read-only memory units (or other memory means such as battery-powered random access memory) which store program instructions and data that adapt handheld microprocessor 12 for operation in a blood glucose monitoring system. More specifically, when the instructions and data of program cartridge 42 are combined with program instructions and data included in the internal memory circuits of microprocessor unit 12, microprocessor unit 12 is programmed for processing and displaying blood glucose information in the manner described below and additional monitors 22 to provide health monitoring for asthma and various other previously mentioned chronic conditions. In each case, the plurality of switches or keys 30, 32, 34, 36, and 38 are selectively operated to provide signals that result in pictorial and/or alphanumeric information being displayed by display unit 42.

Various devices are known that meet the above-set forth description of microprocessor unit 12. For example, compact devices are available in which the plurality of keys allows alphanumeric entry and internal memory is provided for storing information such as names, addresses, phone numbers, and an appointment calendar. Small program cartridges or cards can be inserted in these devices to program the device for various purposes such as the playing of games. More recently, less compact products that have more extensive computational capability and are generally called "palm top computers" have been introduced into the marketplace. These devices also can include provision for

programming the device by means of an insertable program card or cartridge. Alternatively, the program can be loaded into their memory from a network or via a modem connection. A person of average skill in the art will appreciate that there exist other suitable methods for loading programs into suitable computer devices.

Another advantage of realizing handheld microprocessor unit 12 in the form of a compact video game system is the relatively simple, yet versatile arrangement of switches that is provided by such a device. For example, a compact video game system includes a control pad 30 that allows an object displayed on display unit 42 to be moved in a selected direction (i.e., up-down or left-right). As also is indicated in FIG. 1A, compact video game systems typically provide two pair of distinctly-shaped push button switches. A pair of spaced-apart circular push button switches (36 and 38) and a pair of elongate switches (32 and 34) are provided. The functions performed by the two pairs of switches is dependent upon the program instructions contained in each program cartridge 42.

Yet another advantage of utilizing a compact video game system for handheld microprocessor-based unit 12 of FIG. 1A is the widespread popularity and low cost of such units. In this regard, manufacture and sale of a data management unit 10, blood glucose monitor 16 and program cartridge 42 that operate in conjunction with a compact microprocessor-based video allows the self-care health monitoring system of FIG. 1A to be manufactured and sold at a lower cost than could be realized in an arrangement in which handheld unit 12 is designed and manufactured solely for use in the system.

An even further advantage of using a compact video game system for handheld microprocessor 12 is that such video game systems include means for easily establishing the electrical interconnection provided by cable 14. In particular, such compact video game systems include a connector 40 mounted to the game unit housing and a cable that can be connected between the connectors of two video game units to allow interactive operation of the two interconnected units (i.e., to allow contemporaneous game play by two players or competition between players as they individually play identical but separate games). The cable supplied with handheld microprocessor unit 12 can be used as cable 14 to establish serial data communication between the handheld microprocessor unit 12 (compact video game system) and data management unit 10.

Depending upon the operational mode selected by the user, data is supplied to data management unit 10 by blood glucose monitor 16, by additional monitors (20 and 22 in FIG. 1A) or any interconnected computers or data processing facility (such as the hereinafter described user's computer 48 and clearinghouse 54). During such operation, mode switches 30, 32, 34, 36 and 38 are selectively activated so that signals are selectively coupled to microprocessor unit 12 and processed in accordance with program instructions stored in program cartridge 42. The signal processing performed by microprocessor unit 12 results in the display of alphanumeric, symbolic, or graphic information on the video game display 28, which allow the user to control system operation and obtain desired test results and other information.

Although the above-discussed advantages apply to use of the invention by all age groups, employing a compact video game system in the practice of the invention is of special significance in monitoring a child's blood glucose or other health parameters. Children and young adults are familiar

with compact video game systems. Thus, children will accept a health monitoring system incorporating a compact video game system more readily than a traditional system, even an embodiment of the invention that uses a different type of handheld microprocessor unit. Moreover, an embodiment of the invention that functions in conjunction with a compact video game system can be arranged to motivate children to monitor themselves more closely than they might otherwise by incorporating game-like features and/or animation in system instruction and test result displays. Similarly, the program instructions can be included in program cartridges 41, 42 and 43 (or additional cartridges) that allow children to select game-like displays that help educate the child about his or her condition and the need for monitoring.

With continued reference to FIG. 1A, data management unit 10 includes a data port 44 that allows communication between data management unit 10 and a personal computer 48 (or other programmable data processor). Data port 44 is, for example, an RS-232 connection that allows serial data communication between data management unit 10 and personal computer 48. In the practice of the invention, personal computer 48 can be used to supplement data management unit 10 by, for example, performing more complex analyses of blood glucose and other data that has been supplied to and stored in the memory circuits of data management unit 10. With respect to embodiments of the invention configured for use by a child, personal computer 48 can be used by a parent or guardian to review and analyze the child's progress and to produce printed records for subsequent review by a healthcare professional.

Alternatively, personal computer 48 can be used to supply data to data management unit 10 that is not conveniently supplied by using handheld microprocessor switches 30, 32, 34, 36 and 38 as an operator interface to the system of FIG. 1A. For example, some embodiments of the invention may employ a substantial amount of alphanumeric information that must be entered by the system user. Although it is possible to enter such data by using switches 30, 32, 34, 36 and 38 in conjunction with menus and selection screens displayed on display screen 28 of FIG. 1A, it may be more advantageous to use a device such as personal computer 48 for entry of such data. However, if personal computer 48 is used in this manner, some trade-off of system features may be required because data management unit 10 must be temporarily interconnected with personal computer 48 during these operations. That is, some loss of system mobility might result because a suitably programmed personal computer would be needed at each location at which data entry or analysis is to occur. Of course, it will be recognized by a person of average skill in the art that in certain embodiments personal computer 48 can absorb the entire functionality of unit 12 and data management unit 10. A system based on computer 48 only may be more successful with adult patients or when the data to be displayed is very complicated and requires the entire computer screen.

As is indicated in FIG. 1A, data management unit 10 of the currently preferred embodiments of the invention also includes a modem that allows data communication between data management unit 10 and an information service, computing facility or clearinghouse 54 via a conventional telephone line 50 in and a modem 52 that interconnects clearinghouse 54 via telephone line 50.

Clearinghouse 54 facilitates communication between a user of the system and his or her healthcare professional and can provide additional services such as updating system software or downloading specific programs to the user. In

fact, in one embodiment clearing house 54 is the computer used by the clinician. As is indicated by facsimile machine 55 of FIG. 1A, a primary function of clearinghouse 54 is providing the healthcare professional with standardized reports 56, which indicate both the current condition and condition trends of the system user. Although a single facsimile machine 55 is shown in FIG. 1A, it will be recognized that numerous healthcare professionals (and hence facsimile machine 55) can be connected in signal communication with a clearinghouse 54. In this situation each healthcare professional may have his or her own clinician computer linked to clearinghouse 54 according to methods well known in the art.

Regardless of whether a compact video game system, another type of commercially available handheld microprocessor-based unit, or a specially designed unit is used, the system of FIG. 1A provides a self-care blood glucose monitoring system in which program cartridge 42: (a) adapts handheld microprocessor unit 12 for displaying instructions for performing the blood glucose test sequence and associated calibration and test procedures; (b) adapts handheld microprocessor unit 12 for displaying (graphically or alphanumerically) statistical data such as blood glucose test results taken during a specific period of time (e.g., a day, week, etc.); (c) adapts handheld microprocessor unit 12 for supplying control signals and signals representative of food intake or other useful information to data management unit 10; (d) adapts handheld microprocessor unit 12 for simultaneous graphical display of blood glucose levels with information such as food intake; and, (e) adapts handheld microprocessor unit 12 for displaying information or instructions from a healthcare professional that are coupled to data management unit 10 from a clearinghouse 54. In the event that computer 48 absorbs all of the functions of unit 12 and data management unit 10, cartridge 42 or appropriate software is communicated directly to computer 48 instead. Computer 48 then performs all of the above functions. The manner in which the arrangement of FIG. 1A implements the above-mentioned functions and others can be better understood with reference to FIG. 2 discussed further below.

Alternatively, the functionality of handheld unit 12, computer 48, data management unit 10 and modem 52 can be replaced by a single integrated device. Such an embodiment is shown in FIG. 1B, by a schematic block diagram of an integrated device 1. Device 1 includes a microprocessor 2 and a memory 3 connected to microprocessor 2. Memory 3 is preferably a non-volatile memory, such as a serial EEPROM. Memory 3 stores programs or script programs received from clearing house 54, measurements received from monitoring devices 16, 20 or 22, and the patient's responses. Microprocessor 2 also includes built-in read only memory (ROM) which stores firmware for controlling the operation of apparatus 1. The firmware includes a script interpreter used by microprocessor 2 to execute the script programs. The script interpreter interprets script commands which are executed by microprocessor 2. Specific techniques for interpreting and executing script commands in this manner are well known in the art.

Microprocessor 2 is preferably connected to memory 3 using a standard two-wire I<sup>2</sup>C interface. Microprocessor 2 is also connected to user input buttons 4, LED 5, a clock 6, and a display driver 7. Clock 6 indicates the current date and time to microprocessor 2. For clarity of illustration, clock 6 is shown as a separate component, but is preferably built into microprocessor 2. Display driver 7 operates under the control of microprocessor 2 to display information on display 8. Microprocessor 2 is preferably a PIC 16C65 processor

which includes a universal asynchronous receiver transmitter (UART) 9. UART 9 is for communicating with modem 52 and a device interface 11. A CMOS switch 13 under the control of microprocessor 2 alternately connects modem 52 and interface 11 to UART 9.

Modem 52 is connected to a telephone jack 15 through modem jack 17. Modem 52 is for exchanging data with clearing house 54 through telephone line or any other suitable communication network 50. The data includes programs, e.g., script programs which are received from the server as well as responses to queries, device measurements, any required script identification codes, and the patient's unique identification code which modem 52 transmits to the clearing house. Modem 52 is preferably a complete 28.8 K modem commercially available from Cermetek, although any suitable modem may be used.

Device interface 11 is connected to device jacks 19A, 19B, and 19C. Device interface 11 is for interfacing with monitoring devices 16, 20, 22 which can include blood glucose meters, respiratory flow meters, blood pressure cuffs, weight scales, pulse rate monitors or any other suitable patient monitoring devices. Device interface 11 operates under the control of microprocessor 2 to collect measurements from the monitoring devices and to output the measurements to microprocessor 2 for storage in memory 3. In the preferred embodiment, interface 11 is a standard RS232 interface. In alternative embodiments, apparatus 1 may include multiple device interfaces to accommodate monitoring devices which have different connection standards.

As shown in FIG. 2, clearinghouse 54 receives data from a plurality of self-care microprocessor-based healthcare systems of the type shown in either FIG. 1A or FIG. 1B, with the individual self-care health monitoring systems being indicated in FIG. 2 by reference numeral 58. Preferably, the data supplied to clearinghouse 54 by each individual self-care health monitoring system 58 consists of "raw data," i.e., test results and related data that was stored in memory circuits of data management unit 10, without further processing by data management unit 10. For example, with respect to the arrangement shown in FIG. 1A or FIG. 1B, blood glucose test results and associated data such as food intake information, medication dosage and other such conditions are transmitted to clearinghouse 54 and stored with a digitally encoded signal that identifies both the source of the information (i.e., the system user or patient) and those having access to the stored information (i.e., the system user's doctor or other healthcare professional).

As shall be recognized upon understanding the manner in which it operates, clearinghouse 54 can be considered to be a central server for the various system users 58 and each healthcare professional 60. Thus, clearinghouse 54 includes conventionally arranged and interconnected digital processing equipment, i.e., digital signal processor 57 which receives digitally encoded information from user 58 or healthcare professional 60; processes the information as required; stores the information (processed or unprocessed) in memory if necessary; and transmits the information to an intended recipient (i.e., user 58 or healthcare professional 60).

In FIG. 2, rectangular outline 60 represents one of numerous remotely located healthcare professionals who can utilize clearinghouse 54 and the arrangement described relative to FIG. 1A or FIG. 1B in monitoring and controlling patient healthcare programs. Shown within outline 60 is a computer 62 (e.g., personal computer), which is coupled to clearinghouse 54 by means of a modem (not shown in FIG. 2) and

a telephone line 64. Also shown in FIG. 2 is the previously mentioned facsimile machine 55, which is coupled to clearinghouse 54 by means of a second telephone line 68. Using the interface unit of computer 62 (e.g., a keyboard or pointing device such as a mouse), the healthcare professional can establish data communication between computer 62 and clearinghouse 54 via telephone line 64. Once data communication is established between computer 62 and clearinghouse 54, patient information can be obtained from clearinghouse 54 in a manner similar to the manner in which subscribers to various database services access and obtain information.

In particular, the healthcare professional can transmit an authorization code to clearinghouse 54 that identifies the healthcare professional as an authorized user of the clearinghouse and, in addition, can transmit a signal representing the patient for which healthcare information is being sought. As is the case with conventional database services and other arrangements, the identifying data is keyed into computer 62 by means of a conventional keyboard (not shown in FIG. 2) in response to prompts that are generated at clearinghouse 54 for display by the display unit of computer 62 (not shown in FIG. 2).

Depending upon the hardware and software arrangement of clearinghouse 54 and selections made by the healthcare professional via computer 62, patient information can be provided to the healthcare professional in different ways. For example, computer 62 can be operated to access data in the form that it is stored in the memory circuits of clearinghouse 54 (i.e., raw data that has not been processed or altered by the computational or data processing arrangements of clearinghouse 54). Such data can be processed, analyzed, printed and/or displayed by computer 62 using commercially available or custom software. On the other hand, various types of analyses may be performed by clearinghouse 54 with the results of the analyses being transmitted to the remotely located healthcare professional 60. For example, clearinghouse 54 can process and analyze data in a manner identical to the processing and analysis provided by the self-care monitoring system of FIG. 1A or FIG. 1B. With respect to such processing and any other analysis and processing provided by clearinghouse 54, results expressed in alphanumeric format can be sent to computer 62 via telephone line 64 and the modem associated with computer 62, with conventional techniques being used for displaying and/or printing the alphanumeric material for subsequent reference.

The arrangement of FIG. 2 also allows the healthcare professional to send messages and/or instructions to each patient via computer 62, telephone line 64, and clearinghouse 54. In particular, clearinghouse 54 can be programmed to generate a menu that is displayed by computer 62 and allows the healthcare professional to select a mode of operation in which information is to be sent to clearinghouse 54 for subsequent transmission to a user of the system described relative to FIG. 1A or FIG. 1B. This same menu (or related submenus) can be used by the healthcare professional to select one or more modes of operation of the above-described type in which either unmodified patient data or the results of data that has been analyzed by clearinghouse 54 is provided to the healthcare provider via computer 62 and/or facsimile machine 55.

Operation of the arrangement of FIG. 2 to provide the user of the invention with messages or instructions such as changes in medication or other aspects of the healthcare program, e.g., instructional programs, is similar to the operation that allows the healthcare professional to access data sent by a patient, i.e., transmitted to clearinghouse 54 by a

data management unit 10 of FIG. 1A or FIG. 1B. The process differs in that the healthcare professional enters the desired message or instruction via the keyboard or other interface unit of computer 62. Once the data is entered and transmitted to clearinghouse 54, it is stored for subsequent transmission to the user for whom the information or instruction is intended.

With respect to transmitting stored messages or instructions to a user of the invention, at least two techniques are available. The first technique is based upon the manner in which operational modes are selected in the practice of the invention. Specifically, in the currently preferred embodiments of the invention, program instructions that are stored in data management unit 10 and program cartridge 42 cause the system of FIG. 1A or FIG. 1B to generate menu screens which are displayed by display unit 28 of microprocessor unit 12. The menu screens allow the system user to select the basic mode in which the system is to operate and, in addition, allow the user to select operational subcategories within the selected mode of operation. Various techniques are known to those skilled in the art for displaying and selecting menu items. For example, in the practice of this invention, one or more main menus can be generated and displayed which allow the system user to select operational modes that may include: (a) a monitor mode (e.g., monitoring of blood glucose level); (b) a display mode (e.g., displaying previously obtained blood glucose test results or other relevant information); (c) an input mode (e.g., a mode for entering data such as providing information that relates to the healthcare regimen, medication dosage, food intake, etc.); and, (d) a communications mode (for establishing a communication link between data management unit 10 and personal computer 48 of FIG. 1A or FIG. 1B; or between data management unit 10 and a remote computing facility such as clearinghouse 54 of FIG. 2).

In embodiments of the invention that employ a compact video game system for handheld microprocessor unit 12, the selection of menu screens and the selection of menu screen items preferably is accomplished in substantially the same manner as menu screens and menu items are selected during the playing of a video game. For example, the program instructions stored in data management unit 10 and program cartridge 42 of the arrangement of FIG. 1A or FIG. 1B can be established so that a predetermined one of the compact video game switches (e.g., switch 32) allows the system user to select a desired main menu in the event that multiple main menus are employed. When the desired main menu is displayed, operation by the user of control pad 30 allows a cursor or other indicator that is displayed on the menu to be positioned adjacent to or over the menu item to be selected. Activation of a switch (e.g., switch 36 of the depicted handheld microprocessor unit 12) causes the handheld microprocessor unit 12 and/or data management unit 10 to initiate the selected operational mode or, if selection of operational submodes is required, causes handheld microprocessor unit 12 to display a submenu.

In view of the above-described manner in which menus and submenus are selected and displayed, it can be recognized that the arrangement of FIG. 1A or FIG. 1B can be configured and arranged to display a menu or submenu item that allows the user to obtain and display messages or instructions that have been provided by a healthcare professional and stored in clearinghouse 54. For example, a submenu that is generated upon selection of the previously mentioned communications mode can include submenu items that allow the user to select various communication modes, including a mode in which serial data communica-

tion is established between data management unit 10 and clearinghouse 54 and data management unit 10 transmits a message status request to clearinghouse 54. When this technique is used, the data processing system of clearinghouse 54 is programmed to search the clearinghouse memory to determine whether a message exists for the user making the request. Any messages stored in memory for that user are then transmitted to the user and processed for display on display unit 28 of handheld microprocessor unit 12. Of course, the message may include an entire program, e.g., an instructional video. If no messages exist, clearinghouse 54 transmits a signal that causes display unit 28 to indicate "no messages." In this arrangement, clearinghouse 54 preferably is programmed to store a signal indicating that a stored message has been transmitted to the intended recipient (user). Storing such a signal allows the healthcare professional to determine that messages sent to clearinghouse 54 for forwarding to a patient have been transmitted to that patient.

In addition, the program instructions stored in data management unit 10 preferably allow the system user to designate whether received messages and instructions are to be stored in the memory of data management unit 10 for subsequent retrieval or review. In addition, in some instances it may be desirable to program clearinghouse 54 and data management unit 10 so that the healthcare professional can designate (i.e., flag) information such as changes in medication that will be prominently displayed to the user (e.g., accompanied by a blinking indicator) and stored in the memory of data management unit 10 regardless of whether the system user designates the information for storage.

A second technique that can be used for forwarding messages or instructions to a user does not require the system user to select a menu item requesting transmission by clearinghouse 54 of messages that have been stored for forwarding to that user. In particular, clearinghouse 54 can be programmed to operate in a manner that either automatically transmits stored messages for that user when the user operates the system of FIG. 1A or FIG. 1B to send information to the clearinghouse or programmed to operate in a manner that informs the user that messages are available and allows the user to access the messages when he or she chooses to do so.

Practicing the invention in an environment in which the healthcare professional uses personal computer in some or all of the above-discussed ways can be very advantageous. On the other hand, the invention also provides healthcare professionals timely information about system users without the need for a computer (62 in FIG. 2) or any equipment other than a conventional facsimile machine 55 in FIGS. 1 and 2. Specifically, information provided to clearinghouse 54 by a system user 58 can be sent to a healthcare professional 60 via telephone line 68 and facsimile machine 55, with the information being formatted as a standardized graphic or textual report 56. Formatting a standardized report 56 (i.e., analyzing and processing data supplied by blood glucose monitor 16 or other system monitor or sensor) can be effected either by data management unit 10 or within the clearinghouse facility 54.

A preferred embodiment of the invention is focused on sending the patient an educational program corresponding to an educational need as assessed by the system of the invention. The adaptation of the system of FIGS. 1 and 2 for this purpose is shown in detail in FIGS. 3-15.

FIG. 3 shows the main components of a health management system for remotely monitoring a patient and for



training the patient to comply with a treatment plan for a health condition. A healthcare clinic 100 has a clinic server computer 120 that includes a mail server application 140 for managing electronic mail services for clinic 100. Clinic server 120 also includes a master patient database 180 for storing data relating to each patient managed by clinic 100. Clinic server 120 further includes a data management server application 160 for managing and performing database operations taking place on master patient database 180. Clinic server 120 is coupled to a modem M1 for connecting server 120 to a communication network 280.

A clinician computer 200 is networked to clinic server 120. Clinician computer 200 has a clinician mail client application 220 for composing, sending, and receiving electronic mail messages. Clinician computer 200 further includes a local clinician database 260 for storing patient data downloaded from clinic server 120. Clinician computer 200 also has a clinician data management application 240 for managing patient data stored in local clinician database 260. Clinician computer 200 is coupled to a modem M2 for connecting clinician computer 200 to communication network 280.

A patient computing device 320 for collecting patient data relating to the patient's health condition is located at a patient site 300, typically the patient's home. In the preferred embodiment, patient computing device 320 is a personal computer having a display monitor. However, in alternative embodiments, patient computing device 320 may be any information processing and display unit, such as a network terminal, a television set with a set-top cable converter box, a personal digital assistant, or a video educational program system as described above.

Patient computing device 320 includes a patient mail client 340 for sending and receiving electronic mail messages. Patient computing device 320 further includes a local patient database 400 for storing the patient data and a data management application 380 for managing the patient data stored in database 400. Patient computing device 320 is coupled to a modem M4 for connecting patient computing device 320 to communication network 280.

A metering device 420 is connected to patient computing device 320. Device 420 is for measuring a physical characteristic of the patient's health condition, such as blood glucose levels for a diabetic patient or peak flow rates for an asthmatic patient, and for uploading the measurements to computer 320. Specific techniques for connecting a metering device to a patient computing device for remote monitoring of a patient are well known in the art.

An on-line information service 440 having educational documents 460 is connected to communication network 280 through a modem M4. In the preferred embodiment, on-line information service 440 is a world wide web service having educational documents 460 located on a world wide web site, such as the American Diabetes Association's web site or the American Lung Association's web site. Of course, there are many other on-line services such as Compuserve, America On-Line, and other electronically accessible database servers that may be used as a source of educational documents in alternative embodiments.

An educational video educational program 360 for training the patient to comply with a treatment plan for his or her health condition is installed on patient computing device 320. In the preferred embodiment, educational video educational program 360 is a Health Hero® video educational program, such as Packy & Marlon®, commercially available from Health Hero Network, Inc. of Mountain View, Calif.

Educational video educational program 360 is preferably a role-playing educational program that permits a patient to simulate treating his or her health condition. Educational program 360 is further capable of scoring patient responses to the role-playing program to determine the patient's knowledge, comprehension, and attitude in complying with the treatment plan for his or her health condition.

For example, in the educational video educational program Packy & Marlon®, one or two players manage the diabetes of two educational program characters and attempt to progress to higher educational program levels through successful management of the diabetes. Diabetes management steps in the educational program include selecting appropriate foods, taking insulin doses, measuring blood glucose levels, and answering questions about diabetes. Educational program responses are recorded in several categories to indicate the player's knowledge, comprehension, and attitude in managing diabetes. A player's attitude may also be determined by recording whether the player played alone or with a friend, indicating if the player is adjusting socially to his or her health condition.

FIG. 4 is a schematic block diagram illustrating the entering of patient data relating to the patient's health condition into local patient database 400. The patient data includes educational program response information 500 derived by scoring patient responses to educational video educational program 360. Educational program response information 500 includes a knowledge score 530A for indicating the patient's understanding of the treatment plan. Educational program response information 500 also includes a comprehension score 530B for indicating a cognitive ability of the patient to understand an educational program designed to teach compliance with the treatment plan. Educational program response information 500 further includes an attitude score 530C for indicating the patient's attitude toward complying with the treatment plan. The patient data further includes device measurements 540 received from metering device 420 and logbook records 520 of the patient's treatment plan. Logbook records 520 are entered into database 400 using a logbook program 480 included in patient data management application 380.

FIG. 5 shows a sample logbook entry screen 560 of logbook program 480 as it appears on patient computing device 320.

Screen 560 illustrates a typical logbook entry for a diabetic patient. Screen 560 includes a date field 580 and a time field 600 for selecting a specific blood glucose reading 620 from device measurements 540. Screen 560 further includes four radio buttons 640. Each radio button 640 is designed to display a list of events in a list box 660. List box 660 contains a selected event 680 that has been chosen by the patient as the appropriate event corresponding to blood glucose reading 620. Screen 560 also has a notes field 710 for free form entry of other information relating to the patient's treatment plan.

Screen 560 also includes an add medication button 720 for displaying an add medication screen 800, as shown in FIG. 7. Screen 800 includes a list box 810 listing diabetes medications. List box 810 contains a selected medication 820 that has been chosen by the patient. Screen 800 also includes a dosage field 840 for recording a medicine dosage. An OK button 860 and a CANCEL button 880 are for confirming and canceling, respectively, the information entered in screen 800.

Referring again to FIG. 5, a medication field 700 shows the information entered in add medication screen 800. An

OK button 740 and a CANCEL button 760 are for confirming and canceling, respectively, the logbook information entered in screen 560. FIG. 6 illustrates a sample logbook entry screen 780 for an asthmatic patient. FIG. 8 shows a sample add medication screen 900 for the asthmatic patient. The design and use of such a logbook program for entering logbook records 520 into database 400 are well known in the art.

Referring to FIG. 9, clinician data management application 240 includes a clinician data view program 920 for analyzing patient data to determine an educational need of the patient in learning to comply with his or her treatment program. Data view program 920 is capable of displaying a selected subset of device measurements 540 and logbook records 520 in graphical form.

FIG. 10 shows a data view 980 produced by data view program 920 on the screen of clinician computer 200. Data view 980 is a sample data view of a diabetic patient's data. Data view 980 includes a selected subset 101 of device measurements 540 and logbook records 520 corresponding to one day in the patient's treatment plan indicated by a date field 103. Data view 980 further includes a graph 102 of selected subset 101. A set of control buttons 104 allow the clinician to scroll through different days or weeks of the patient's data to quickly view selected subsets from different days. FIG. 11 shows a sample data view 106 for an asthmatic patient's data. Specific techniques for creating a data view program to display data in this manner are well known in the art.

Referring again to FIG. 9, patient data management application 380 includes a patient data view program 960 having the same functionality as clinician data view program 920. Thus, patient data view program 960 is also capable of displaying data views 980 and 106 on patient computing device 320. Application 380 further includes a document view program 970 for displaying an educational document retrieved from on-line information service 440, as will be explained in the operation section below.

Clinician mail client 220 is of the type that allows a user to compose an electronic mail message containing an embedded pointer to a selected program installed on patient computing device 320. Mail client 220 further allows the pointer to be represented in the message as an icon. The pointer may optionally include specific data and instructions to be executed by the selected program or point to an address that has a set of instructions to be executed by the program. Patient mail client 340 is of the type that allows a user to start the selected program on patient computing device 320 by selecting the icon in the electronic mail message. A suitable electronic mail program for performing these functions is Microsoft Exchange™ commercially available from Microsoft Corporation of Redmond, Wash. The programming of an electronic mail application to perform these functions is well known in the art.

FIG. 12 illustrates a sample electronic mail message 940 in detail. Message 940 contains an icon 110 that includes an embedded pointer to patient data view program 960. Icon 110 further includes patient data from a specific date and instructions for program 960 to display the patient data in graphical form. An alternative electronic mail message 112 is illustrated in FIG. 13. Message 112 contains an icon 114 that includes an embedded pointer to educational video educational program 360. Icon 114 further includes instructions for video educational program 360 to execute Fig educational program level two. A third electronic mail message 121 is illustrated in FIG. 14. Message 121 contains

an icon 122 that includes an embedded pointer to document view program 970. Icon 122 further includes an educational document retrieved from on-line information service 440 and instructions for program 970 to display the educational document.

The operation of the preferred embodiment is illustrated in FIG. 15. FIG. 15 is a flow chart showing a preferred method of using the health management system for remotely monitoring a patient and for training the patient to comply with a treatment plan for his or her health condition. In step 202, the patient is tested with metering device 420 to produce device measurements 540. Typically, the test is self-administered by the patient. Next, measurements 540 are uploaded to patient computing device 320, step 204, and stored in local patient database 400.

Once device measurements 540 are stored in database 400, the patient enters logbook records 520 into database 400 using logbook program 480, step 206. Additionally, the patient plays educational video educational program 360, entering educational program responses into patient computing device 320. As the patient plays video educational program 360, the patient's educational program responses are scored to produce knowledge score 530A, comprehension score 530B, and attitude score 530C. Knowledge score 530A, comprehension score 530B, and attitude score 530C are stored as educational program response information 500 in database 400, step 208.

Next, educational program response information 500, logbook records 520, and device measurements 540 are transmitted through communication network 280 to clinic server 120 and stored in master patient database 180, step 210. In a typical implementation, clinic 100 manages the healthcare of hundreds of patients and the data for each patient is stored in master patient database 180. A clinician at clinician computer 200 downloads patient data of a particular patient for whom he or she is responsible from master patient database 180 to local clinician database 260, step 212.

The downloaded patient data is analyzed in clinician computer 200 using clinician data view program 920, step 214. As shown in FIG. 10, data view program 980 displays on clinician computer 200 graph 102 of selected subset of data 101. The clinician also analyzes knowledge score 530A, comprehension score 530B, and attitude score 530C to assess the patient's psychological state. Based on analysis of the patient data, the clinician determines an educational need of the patient for learning to comply with a treatment program, step 216. A first example of such an educational need is illustrated in FIG. 12. As indicated in electronic mail message 940, the clinician has determined that the patient needs to learn the health consequences of failing to eat balanced meals in a diabetes treatment plan.

A second example of an educational need is illustrated in FIG. 13. As indicated in electronic mail message 112, the clinician has determined that the patient needs to learn the importance of taking medication. A third example of an educational need is illustrated in FIG. 14. As indicated in electronic mail message 121, the clinician has determined that the patient needs to learn how to treat diabetes while traveling. Of course, these are just a few examples of possible educational needs of the patient. The clinician may identify many other educational needs, such as the patient's need to learn coping skills, communication skills, and other social adjustment factors.

Once the clinician has determined the patient's educational need, he or she selects an educational program cor-



responding to the educational need, step 218, and embeds in an electronic message a pointer or a prompt to the educational program, step 221. The program will execute when the patient selects the pointer or responds to the prompt. In the preferred embodiment, the educational program is selected to be either patient data view program 960, educational video educational program 360, or document view program 970 depending on the educational need determined by the clinician.

FIG. 12 shows an example of the clinician selecting data view program 960 as the educational program. The clinician embeds a pointer to program 960 in icon 110. The clinician further loads icon 110 with patient data from a specific day and instructions for program 960 to display the patient data in graphical form. FIG. 13 shows an example of the clinician selecting an educational program level of educational video educational program 360 as the educational program. The clinician embeds a pointer to the selected educational program level of video educational program 360 that has an educational content corresponding to the patient's educational need. FIG. 14 shows an example of the clinician selecting document view program 970 as the educational program. The clinician embeds a pointer to program 970 in icon 122. The clinician further loads icon 122 with an educational document retrieved from information service 440.

Next, the electronic message containing the embedded pointer is transmitted from clinician computer 200 to patient computing device 320 through mail server 140 and communication network 280, step 222. The selected educational program is then started on the patient computing device by selecting the embedded pointer in the electronic mail message, step 224, typically by clicking the icon in which the pointer is embedded with a mouse or pointing device.

As the patient works with the educational program, he or she continues the feedback loop with the clinician, step 226, by returning to step 202 and repeating the method described. With this continuous feedback loop between the patient and clinician, the clinician is able to monitor the patient's progress and effectively train the patient to comply with the treatment plan.

#### SUMMARY, RAMIFICATIONS, AND SCOPE

Although the above description contains many specificities, these should not be construed as limitations on the scope of the invention but merely as illustrations of the presently preferred embodiment. Many other embodiments of the invention are possible. For example, in one alternative embodiment, the clinic server is eliminated from the system so that the clinician computer exchanges information directly with the patient computing device. The clinic server is presently preferred for performing resource intensive operations, such as storing large amounts of patient data, but the clinic server is not necessary to enable the system and method of the invention. In embodiments that include the clinic, server, the clinic server need not be physically located at the clinic. The server may be located off-site and networked to the clinician computer.

Additionally, the preferred embodiment describes the use of modems for connecting the various computers in the health management system to the communication network. However, it is obvious that many other types of connections may be employed, such as ethernet connections. Specific techniques for networking computers are well known in the art.

Further, the logbook entry screens illustrated are exemplary of just one possible embodiment of the invention. In

alternative embodiments, the logbook entry screens and logbook records include fields for entering and storing other health-related parameters, such as the patient's dietary intake and exercise routines. Similarly, the data views illustrated are exemplary of just one possible embodiment. Many other data views are possible, such as weekly views of the patient's data, trend graphs of the patient's data, and calendar views of the patient's logbook records.

Although the preferred embodiment describes a system and method for training patients having diabetes or asthma, the invention is not limited to patient's with these diseases. The system and method of the invention are equally effective for training patients to comply with treatment plans for other health conditions, such as cardiovascular diseases, high blood pressure, mental health conditions, addictions, or diet and exercise problems.

Therefore, the scope of the invention should be determined, not by examples given, but by the appended claims and their legal equivalents.

I claim:

1. A method for remotely monitoring a patient and for training the patient to comply with a treatment plan for a health condition, the method comprising the following steps:

- a) entering in a patient computing device data relating to the health condition;
- b) transmitting the data from the patient computing device to a clinician computer via a communication network;
- c) analyzing the data received in the clinician computer to determine an educational need of the patient;
- d) selecting in the clinician computer an educational program corresponding to the educational need;
- e) transmitting an electronic message from the clinician computer to the patient computing device, wherein the electronic message contains an embedded pointer to the selected educational program; and
- f) starting the educational program on the patient computing device by selecting the embedded pointer in the electronic message.

2. The method of claim 1, wherein the educational program comprises an educational video program.

3. The method of claim 1, wherein the educational program comprises questions.

4. The method of claim 3, wherein patient answers to the questions are sent to the clinician computer to create and update a patient database.

5. The method of claim 1, wherein the educational program comprises a patient data view program for displaying a selected subset of the data in graphical form.

6. The method of claim 1, wherein the educational program comprises a document view program for displaying an educational document.

7. The method of claim 6, wherein the educational document is retrieved from an on-line information service connected to the communication network.

8. The method of claim 1, wherein the embedded pointer to the educational program comprises an icon.

9. The method of claim 1, wherein the data comprises measurements of a physical characteristic of the health condition and wherein the entering step comprises:

- a) testing the patient with a metering device to produce the measurements; and
- b) uploading the measurements from the metering device to the patient computing device.

10. The method of claim 1, wherein the data comprises records of the treatment plan and wherein the records are

entered in the patient computing device using a logbook program installed on the patient computing device.

11. The method of claim 1, wherein the data comprises information derived from patient responses to an educational video program played on the patient computing device and wherein the patient responses are entered by the patient while playing the educational video program.

12. The method of claim 11, wherein the information derived from the patient responses comprises a comprehension score for indicating a cognitive ability of the patient to understand the educational video program.

13. The method of claim 11, wherein the information derived from the patient responses comprises a knowledge score for indicating the patient's understanding of the treatment plan.

14. The method of claim 11, wherein the information derived from the patient responses comprises an attitude score for indicating the patient's attitude toward complying with the treatment plan.

15. The method of claim 1, wherein the data is analyzed by a clinician using a clinician data view program on the clinician computer.

16. A system for remotely monitoring a patient and for training the patient to comply with a treatment plan for a health condition, the system comprising:

- a) a patient computing device for collecting data relating to the health condition;
- b) a clinician computer having an analysis means for analyzing the data to determine an educational need of the patient, the clinician computer further having a message means for composing an electronic message containing an embedded pointer to an educational program that corresponds to the educational need; and
- c) a communication network for connecting the patient computing device to the clinician computer and for transmitting the data and the electronic message therebetween;

wherein the patient computing device further has a means for starting the educational program when the patient selects the embedded pointer in the electronic message.

17. The system of claim 16, wherein the educational program comprises an educational video program played on the patient computing device.

18. The system of claim 16, wherein the educational program comprises a patient data view program for displaying a selected subset of the data in graphical form.

19. The system of claim 16, wherein the educational program comprises a document view program for displaying an educational document.

20. The system of claim 16, wherein the analysis means comprises a clinician data view program for displaying a selected subset of the data in graphical form.

21. The system of claim 16, wherein the embedded pointer to the educational program comprises an icon.

22. A method for remote patient monitoring and remote patient training using a computer system, the computer

system comprising a clinician computer, a patient computing device having an educational program loaded thereon, and a communication network connecting the clinician computer to the patient computing device, the method comprising the following steps:

- a) entering in the patient computing device data relating to a health condition of a patient;
- b) transmitting the data from the patient computing device to the clinician computer via the communication network;
- c) analyzing the data received in the clinician computer to determine an educational need of the patient;
- d) selecting a segment of the educational program having an educational content corresponding to the educational need;
- e) transmitting an electronic message from the clinician computer to the patient computing device, wherein the electronic message contains an embedded pointer to the selected segment; and
- f) starting the educational program on the patient computing device at the selected segment by selecting the embedded pointer in the electronic message.

23. The method of claim 22, wherein the data comprises measurements of a physical characteristic of the health condition and wherein the entering step comprises:

- a) testing the patient with a metering device to produce the measurements; and
- b) uploading the measurements from the metering device to the patient computing device.

24. The method of claim 22, wherein the data comprises records of a treatment plan for the health condition and wherein the records are entered into the patient computing device using a logbook program installed on the patient computing device.

25. The method of claim 22, wherein the data comprises information derived from patient responses to the educational video program and wherein the patient responses are entered in the patient computing device by the patient while playing the educational video program.

26. The method of claim 25, wherein the information derived from the patient responses comprises a comprehension score for indicating a cognitive ability of the patient to understand the educational video program.

27. The method of claim 25, wherein the information derived from the patient responses comprises a knowledge score for indicating the patient's understanding of the treatment plan.

28. The method of claim 25, wherein the information derived from patient responses comprises an attitude score for indicating the patient's attitude toward complying with the treatment plan.

29. The method of claim 22, wherein the embedded pointer to the selected segment comprises an icon.

\* \* \* \* \*

UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 5,960,403  
DATED : September 28, 1999  
INVENTOR(S) : Stephen J. Brown

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page.

**Related U.S. Application Data** is amended as follows:

-- Continuation-in-part of application No. 08/481,925, Jun. 7, 1995, Pat. No. 5,899,855, which is a continuation of application No. 08/233,397, Apr. 26, 1994, now abandoned, which is a continuation-in-part of application No. 07/977,323, Nov. 17, 1992, Pat. No. 5,307,263, and a continuation-in-part of application No. 08/666,242, Jun. 20, 1996, abandoned. --

Column 7.

Line 22, the word "persona:" should be -- personal. --

Line 27, the word "with" should be -- With. --


Column 15.

Line 65, the word "Fig" should be deleted.

Signed and Sealed this

Twenty-third Day of April, 2002

Attest:



Attesting Officer

JAMES E. ROGAN  
Director of the United States Patent and Trademark Office